MOTREC

E-280B

OPERATOR AND MAINTENANCE MANUAL
SPARE PARTS LISTS INCLUDED

SERIAL NUMBER : 900000 & UP

Printed in Canada

One Year Limited Warranty

Effective April 25, 2005, MOTREC, Inc. (MOTREC) hereby warrants to the Original Retail Purchaser (Owner) that any of its vehicles shall be free from any defect in materials for a period of 90 DAYS while in the possession of such Original Retail Purchaser. This warranty IS NOT TRANSFERABLE to any subsequent Buyer.

The warranty period is extended to one year or one thousand (1,000) hours, which ever first occurs, on the electric motor, differential (parts that bathe in oil) and the electronic speed controller. MOTREC makes no warranty or representation with respect to the internal combustion engine, tires and batteries, since their respective manufacturers cover such parts. Accessories (light, gage, horn, etc), electrical contacts (switch, solenoid, contactor, relay), diodes & fuses, belts & pulleys, filters & spark plugs, lubricants, brake linings & shoes, brake drums & discs, seals, seats, trim and other items subject to wear are not included in this warranty; nor is any item that in MOTREC sole opinion, shows evidence of neglect, misuse, abuse, collision or alteration.

This warranty shall not apply to normal maintenance requirements as described in the User Manual, and to damages during shipment. The latter is the carrier's responsibility. No compensation will be allowed for delays.

To initiate warranty coverage on any MOTREC vehicle, the Dealer must complete and return the “Sales/Installation Report” to MOTREC within 30 days after delivery to the Original Retail Purchaser; or within 90 days after the delivery date to the Dealer, which ever occurs first. Failure to follow these procedures will result in considering the warranty coverage effective as of the shipment date from the factory.

The defective vehicle must be returned, at the Owner's expense, to an authorised MOTREC Dealer within 30 days after failure. The Owner will not be charged for parts and labour required for warranty repairs, which must be performed by an authorised MOTREC Dealer only. The vehicle will be returned at the owner’s expense. The Warranty Claim Forms must be completed and returned with the defective part(s) to MOTREC within 30 days after repair was done. No compensation will be allowed for damages caused by vehicle downtime.

It is the responsibility of the owner of the vehicle to make sure that the driver is properly trained and instructed in the safety features and operation of the vehicle, including vehicle stability, as required by OSHA and ANSI-B56. Operators shall read, understand and follow the safety and operating instructions in MOTREC Manual before driving the vehicle. Operators shall not be permitted to drive the vehicle unless a complete and adequate training has been provided. Driving a vehicle constitutes a hazard. The driver is responsible for the control of the vehicle while driving and must always evaluate and care for all peculiar situations that he or she may meet while driving. The driver assumes the inherent hazards related to this activity. The vehicle is designed for off-road use only. MOTREC disclaims any liability for incidental or consequential damages, to include, but not be limited to, personal injury or property damage arising from vehicle misuse, lack of maintenance or any defect in the vehicle.

It is the responsibility of the Owner of the vehicle to make sure that the service technicians are properly trained as required by OSHA and ANSI-B56. Service technicians shall read, understand and follow instructions in the MOTREC manual before servicing the vehicle. Only qualified and authorized personnel shall be permitted to maintain, repair, adjust and inspect the vehicle.

MOTREC prohibits, and disclaims responsibility for, any vehicle modification altering the weight distribution and stability, increasing the speed or affecting the safety of the vehicle. Such modifications can cause serious personal injury or property damage for which MOTREC disclaims any responsibility.

For Owners that are located outside North America, the warranty period starts the date of shipment from the factory, and the defective parts must be returned at the Owner's expense to MOTREC prior to warranty repair.

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INSTRUCTIONS

SAFETY WARNINGS FOR OPERATORS

- FAILURE TO OBEY THE FOLLOWING SAFETY RULES MAY RESULT IN SEVERE INJURY.
- It is the responsibility of the owner of this vehicle to train operators to ensure that they understand the operating characteristics of this vehicle, including training in vehicle stability, and obey the following safety rules and guidelines. Owner shall comply with OSHA and ANSI/ITSDF B56.8 & B56.9 Standards for vehicle use, safety rules, operator training and certification. Do not drive this vehicle unless you are a qualified operator.
- Do not drive this vehicle under the influence of drugs or alcohol.
- Do not drive this vehicle on public roads and highways. This vehicle is designed to be driven in buildings.
- The electrical system of this vehicle will make sparks which can ignite inflammable materials. Never use the vehicle in hazardous areas where there are inflammable materials, explosive dust or fumes in the air.
- Have your vehicle inspected regularly by trained personnel, and cease operation if a malfunction occurs.
- Do not open battery compartment to prevent battery explosion, acid splashing, severe damage to eyes or skin.
- Do not open motor compartment. Keep clear from moving, rotating(wheels, sheaves, etc) or lifting parts.
- Never carry more passengers than number allowed for this vehicle. Wait until all occupants are seated and holding on before moving. Always keep all body parts inside vehicle. Keep both hands on steering wheel.
- Do not exceed the vehicle cargo load capacity and gross trailing weight capacity, rated for flat hard even surface. Different operating conditions such as loose terrain or ramps reduce vehicle capacity.
- Avoid loose, unbalanced or top-heavy loads to keep a good stability and prevent overturn. Do not load cargo that can fall off the vehicle. Do not carry cargo that is longer, wider or higher than this vehicle.
- Always depress slowly the accelerator for smooth acceleration. Avoid stunt driving or horseplay.
- Avoid sharp turns, always slow down before turning, to prevent vehicle overturn or trailer jack knife. Vehicle is more sensitive to overturn and jack knife when traveling on inclines or when carrying a heavy load.
- Always drive straight up and down the face of an incline, never across the face, to prevent overturn and trailer jack knife. Drive slower and start applying brakes sooner on inclines to adjust for longer stopping distance.
- Use extra care and drive slowly in reverse, in congested areas or on wet or slippery ground.
- Keep to the right under normal conditions. Maintain a safe distance from all objects.
- Slow down and sound the horn when approaching a corner or other blind intersections.
- Before leaving the vehicle, park on a level ground flat surface, turn off all switches, set the forward/reverse switch to neutral, set the parking brake, remove the key. Do not park the vehicle on an incline.
- Before battery charging, park the vehicle in a well ventilated area set for. Do not operate it when charging. To interrupt a charging cycle, disconnect the AC plug; disconnecting the DC plug or a battery terminal, or operating the vehicle, could damage the charger and produce a spark, battery explosion and acid splashing.
- Use another driver to steer this vehicle while it is towed. Be sure the driver uses brakes when you slow or stop the towing vehicle. Do not exceed 5 MPH or carry any passenger while towing this vehicle.

OPERATING INSTRUCTIONS

It is the responsibility of the owner of this vehicle to ensure that the operator understands the operating characteristics of this vehicle, and obeys the safety instructions in this manual and ANSI/ITSDF B56.8 & 9 Standards. Do not drive this vehicle unless you are a certified operator as required by OSHA.

BEFORE TURNING ON KEYSWITCH

Set to neutral, set parking brake, check for visible damage, check brake pedal.

AFTER TURNING ON KEYSWITCH

Check safety devices: seat switch, reverse alarm, motion beeper, strobe light, and all other safety devices.

BATTERIES

Never open the battery compartment unless you have received proper training for battery maintenance.
Batteries emit explosive hydrogen gas that can be ignited by a spark or loose terminal. Battery acid causes severe damage to eyes or skin. Flush the contaminated area immediately with water. Park the vehicle in a well ventilated area for battery charging. Most battery chargers come with an electronic control that starts when the charger is plugged and stop when the battery is fully charged. To interrupt the charging cycle, disconnect the AC-plug, do not disconnect the DC plug.

BATTERY DISCHARGE INDICATOR

The green light moves from right to left as batteries are being discharged. When the green light is at the last position on the left the batteries must be recharged. A flashing light warns the operator that further discharge will damage batteries. See HOBBS indicator instructions.

EMERGENCY SAFETY DEVICE

The emergency push button or battery disconnect handle, when present, should only be used in case of emergency. Use the key switch for normal ON/OFF control.

KEYSWITCH

Depress brake pedal and turn the key switch clockwise for on position. Always turn off all switches, set the F/R selector to neutral, set the parking brake, remove the key before leaving the vehicle.

HORN

Depress the horn button on the steering column or handle bar.

F/R SWITCH

Three positions with neutral at center. Depress the front part of the rocker switch for forward direction. Depress the rear part of the rocker switch for reverse direction. Always set switch to neutral, turn off all switches, set the parking brake, remove the key before leaving the vehicle.

ACCELERATOR PEDAL

It is designed for right foot operation only, and controls the speed of the vehicle. Apply slowly.

FOOT BRAKE PEDAL

It is designed for right foot operation only. The brake force is proportional to the pressure on the pedal.

PARKING BRAKE

Pull handbrake lever to apply. Never park the vehicle on an incline. Always turn off all switches, set the F/R selector to neutral, set the parking brake, remove the key before leaving the vehicle.

MAINTENANCE

SAFETY WARNINGS FOR SERVICE TECHNICIANS

FAILURE TO OBEY THE FOLLOWING SAFETY RULES MAIN RESULT IN SEVERE INJURY.

Owner shall comply with OSHA and ANSI/ITSDF B56.8 & B56.9 Standards for vehicle maintenance.

Only qualified and authorized personnel shall be permitted to maintain, repair, adjust and inspect carriers, vehicles, tractors, and batteries.

Before any maintenance work, park the vehicle on flat level surface, turn off all switches, remove key, lift wheels off the ground and secure with jack stands of adequate capacity. Don't connect charger.

Keep clear from moving parts such as tires, sheaves and motor.

Follow the maintenance instructions applicable to the type of repair, maintenance, or service.

Always wear a face shield and gloves when working around batteries.

Before opening the battery compartment, disconnect the charger, turn off all switches and remove the key. Batteries emit highly explosive gases which greatly increase when charging; do not disturb connections or produce sparks around batteries to avoid a battery explosion and acid splashing. Battery acid causes severe damage to eyes or skin. Flush contaminated area immediately with water.

Use insulated tools to avoid sparks that can cause battery explosion and acid splashing.

Use two counteracting tools, double-wrench technique, when disconnecting or tightening terminals on the battery and the speed controller to avoid cracking the terminal or battery post welds.

Before cleaning or replacing a battery, charger, speed controller, contactor, relay, diode, or any other component in the power circuit, always disconnect the charger, turn off all switches, remove the key, wear a face shield and gloves, identify battery polarity and disconnect battery leads, discharge the capacitor in the controller with a 10 ohms, 25 W resistor for a few seconds across B+ and B-.

After cleaning, the power must not be reapplied until terminal areas are thoroughly dry.

On EE-Rated vehicles make sure that the control box is sealed, the static strap makes good contact with the ground, the motor is sealed by bands, the cable protectors are properly installed.

Keep cables and wires clear from mechanical and rubbing action. Make sure that cable insulation is free from cutting or visible damage. Make sure that EE-Rated cable protectors are properly installed.

Before replacing a fuse or circuit breaker, identify the cause of failure and repair.

Programmable controllers must be programmed using the parameter settings in this service manual, before connecting the motor, to avoid sudden vehicle movement and accident.

Do not try to increase motor speed by changing parameter settings in the speed controller; it can cause accident and severe damage to the motor.

SEPEX speed controls are protected by a diode in the power circuit to filter inductive loads in the event of a sudden power interrupt. Some speed controllers require a diode to filter inductive loads on the KSI input. Removing the diodes will cause the speed control failure.

Before resuming maintenance operations, inspect safety warnings stickers and replace any if damage is found and part of the text can't be read.

Check decals and labels, see "DECAL AND LABELS" page.

DECALS AND LABELS

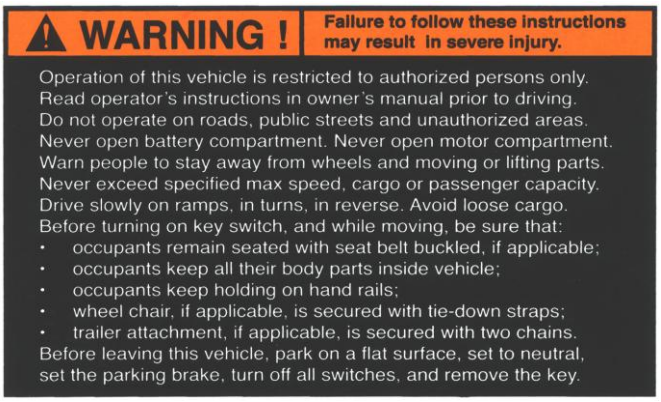
! CAUTION !

The images included in this section depict the decals/markings installed on the vehicle. It is of the utmost importance that theses decals/markings remain unaltered and readable. Else, the sticker or the part baring the marking has to be replaced.

Dashboard security warning label:
5100000002

WARNING !
Failure to follow these instructions may result in severe injury.
Operation of this vehicle is restricted to authorized persons only.
Read operator's instructions in owner's manual prior to driving.

General security warning label:
5100000001

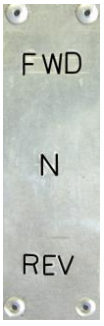

WARNING !
Failure to follow these instructions may result in severe injury.
Operation of this vehicle is restricted to authorized persons only.
Read operator's instructions in owner's manual prior to driving.
Do not operate on roads, public streets and unauthorized areas.
Never open battery compartment. Never open motor compartment.
Warn people to stay away from wheels and moving or lifting parts.
Never exceed specified max speed, cargo or passenger capacity.
Drive slowly on ramps, in turns, in reverse. Avoid loose cargo.
Before turning on key switch, and while moving, be sure that:
• occupants remain seated with seat belt buckled, if applicable;
• occupants keep all their body parts inside vehicle;
• occupants keep holding on hand rails;
• wheel chair, if applicable, is secured with tie-down straps;
• trailer attachment, if applicable, is secured with two chains.
Before leaving this vehicle, park on a flat surface, set to neutral, set the parking brake, turn off all switches, and remove the key.

When an emergency push button is installed, this label is required (located under push button): # 3109800006

When a disconnect handle is installed, this label is required (located in front of handle):
4800012J

Respectively, key switch markings, forward/reverse selector markings and light switch marking:

266211



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PERIODIC MAINTENANCE CHECKLIST

REVISION 080206

! WARNING !
Maintenance operations must be made by properly trained service technicians.

- Keep clear from moving parts such as tires, sheaves and motor.
- Check for all EE protections, when applicable, and keep cables and wires clear from mechanical and rubbing action
- Batteries contain sulphur acid that can cause severe burns on skin or eyes.
- When working around batteries, wear acid proof protective equipment: face shield and gloves.
- Use electrically insulated tools to avoid sparks that can cause battery explosion.
- Before any maintenance work, park the vehicle on a flat level surface, turn off all switches, remove the key, lift the wheels off the ground and secure with jack stands of adequate capacity, identify and disconnect battery leads. Don't connect the charger.

CHECK/PERFORM — PERIOD HOURS	DAY	WEEK 20	MONTH 50	QUART. 200	YEAR 1000	2 YEARS 2000
MECHANICAL DAMAGE, OIL LEAKS	X					
REVERSE ALARM, DEADMAN SWITCH	X					
STATIC STRAP, min 2" contact with ground	X					
TIRE PRESSURE, pressure rating on tire		X				
CHECK/FILL BATTERIES, add distilled water to cover plates. Fill to recommended level after batteries have been fully charged.		X				
WARNING DECALS & MARKINGS			X			
EE-Rated CABLE PROTECTORS, SEALED MOTOR, SEALED CONTROL BOX, STATIC STRAP.			X			
MASTER CYLINDER FLUID (DOT 3)			X			
BRAKE PEDAL TRAVEL 2" (50 mm) maximum travel			X			
STEERING FOR PLAY			X			
PARKING BRAKE LEVER requires 75 lbs. (34 kg) force to apply			X			
BELTS AND PULLEYS -10 lbs (5kg). force for 1/8" (3mm) deflexion; -pulleys alignment, see procedure.				X		
CLEAN/TIGHTEN WIRE TERMINALS				X		
WASH BATTERY TOP WITH WATER				X		
MOTOR BRUSHES FOR WEAR -brushes must exceed holders				X		
ACCELERATOR ADJUSTMENT -1/8" (3 mm) travel to activate micro-switch; -0 to 50 ohms when micro-switch activated; -4500 to 5500 ohms with pedal down.				X		
HYDR. BRAKE LINES FOR LEAK				X		
STEERING ASSEMBLY, as instructed				X		
BRAKE MECHANICAL LINKAGES for wear & play				X		
BRAKE LININGS FOR WEAR 1/16" (2 mm) minimum lining thickness. 6 mm minimum thickness for brake-pulley lining.				X		
LUBRICATE (GREASE EP-2) brake pedal pivots, steering column, ball joints and kingpins.				X		
OIL (SAE 30) LEVEL IN DIFFERENTIAL Before adding oil, check oil seals for leaks.				X		
FRONT WHEEL BEARINGS PLAY				X		
TIGHTEN NUTS/BOLTS, electric terminals; drive; steering; brakes; suspension; body.				X		
REPLACE DIFFERENTIAL OIL(SAE 30)					X	
CLEAN AND RE-PACK FRONT HUBS					X	
SERVICE DIFFERENTIAL, replace the three oil seals, wheel bearings, oil (SAE 30)						X

ACCELERATOR

GEAR

- Remove the cover.
- Backlash between gears must be reduced to a minimum by sliding holder; use locktite 262 to lock the three screws.
- When the plastic gear is fully depressed a small backlash must remain between the gears.
- When the plastic gear is released its rear portion must not exceed the pedal case.

MICRO-SWITCH

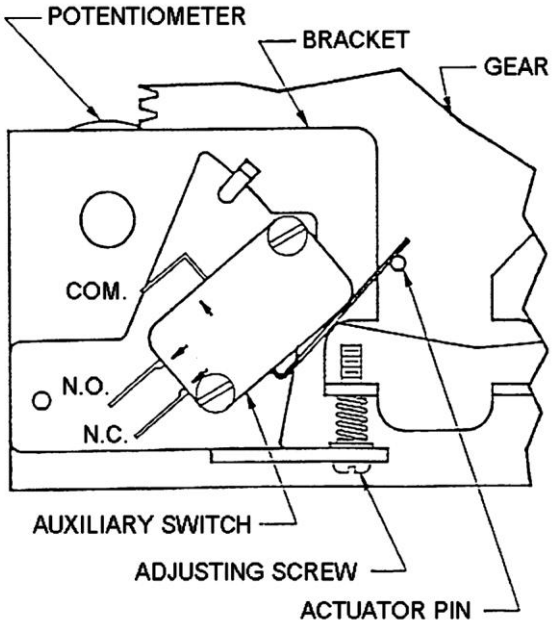
The micro-switch must deactivate the on/off solenoid when the accelerator is released; turn the adjusting screw (shown on figure below) to adjust the micro-switch height.

POT

- Remove the terminals 2 and 3 on PMC to measure resistance signal.
- When the micro-switch is activated the signal must be less than 50 ohms. When the front portion of the pedal is fully depressed the signal must be more than 4600 ohms.
- To modify the resistance, turn the adjusting screw to change the micro-switch height (see figure below).

Proceed with the same verifications after the accelerator cover is on and then connect terminals 2 and 3.

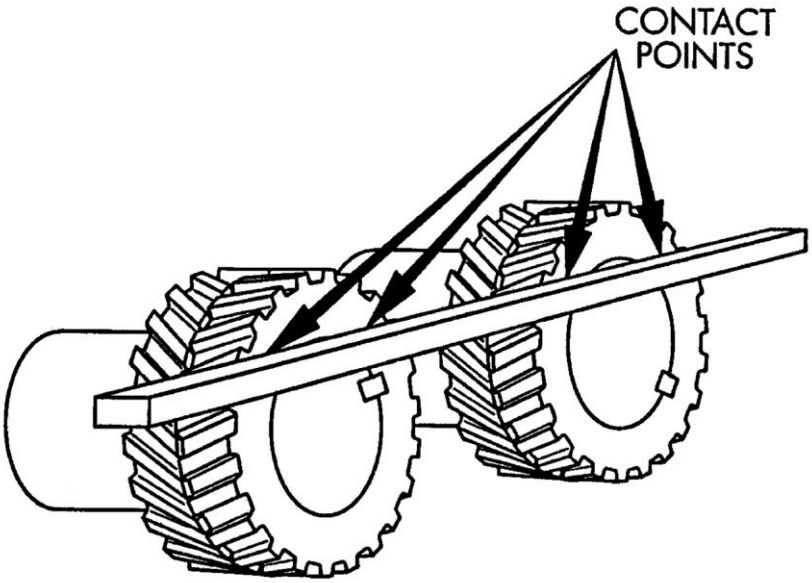
AUXILIARY SWITCH IS WIRED N.O. WITH BLUE LEAD TO COM. & ORANGE LEAD TO N.O. CIRCUIT. THE GREEN LEAD IS GROUNDED. AUXILIARY SWITCH IS SHOWN WITH THE TREADLE IN THE UP POSITION. SWITCH WILL ACTUATE AT BEGINNING OF TREADLE STROKE. SYMBOLS COM., N.O. & N.C. ARE TERMINAL MARKINGS, AS MARKED ON SWITCH.



BELT INSTALLATION AND TENSIONING

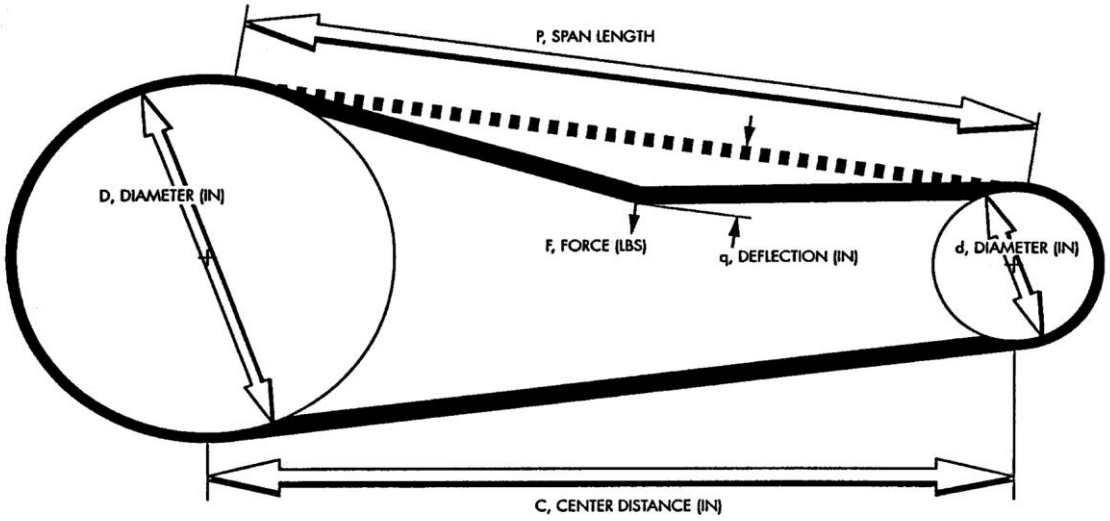
INSTALLATION

Adjust the sprockets using a straight edge. Slide up the edge on the larger pulley until it contacts the smaller pulley. Properly adjusted pulleys will provide three points of contact. Properly aligned pulleys will provide four points of contact. Tighten setscrews and recheck alignment.



TENSIONING

Check the force F required to provide a deflection of 1/8 in. If the measured force is less than 15 lbs then lengthen centre distance C.



HYDRAULIC & PARKING BRAKES

Revision 2008-02-06

DRUM BRAKES

Remove brake drums and check lining wear. Replace shoes and springs if the lining thickness is 1/16" (2mm) or less. Turn the brake adjustment to reduce the clearance between lining and drum. Wheels must turn free when the pedal is released.

DISC BRAKES

Check pad linings. Replace pads if lining thickness is 1/16" (2 mm) or less.

PARKING BRAKE

Replace cables and stoppers if cable play exceeds 1/8" (4mm).
Wheels and/or differential pinion must turn freely when the parking brake is released.
On pinion brake, use spacers at pad fixed ends to reduce space between pads and pulley to 1mm.
To install new cables and stoppers:
-insert the new cable through the hand lever end;
-pull the cable out from the brake assembly end;
-insert the stopper on the cable and leave a maximum play of 1mm;
-for a two-cable system, make sure that cable length is the same at hand lever end;
-tighten ¼-ncx3/4 grade-5 bolt in stopper at 8 LbFt (11NM) torque;
-cable must extend 1.5" (4cm) out of the cable stopper, cut cable excess.

Once cable play has been checked and/or adjusted, turn the knob on the brake lever until a force of 75 Lbs or 34 kg is required on the handle to set the parking brake.

BRAKE PEDAL

If the brake pedal becomes soft or spongy, air may have entered the hydraulic system and the brake system has to be bled:

1. fill the master cylinder with brake fluid (DOT-3);
2. bleed front callipers one at a time by having someone applying a steady pressure on the brake pedal, and close the bleeder before allowing the brake pedal to return to up position;
3. fill the master cylinder with brake fluid (DOT-3);
4. bleed rear wheel brakes one at a time, following the same procedure;
5. fill the master cylinder with brake fluid (DOT-3);
6. clean every fitting and line, remove traces of oil;
7. apply a continuous pressure on the brake pedal for about five minutes ;
8. Finally, inspect brake lines and fittings for leaks ;

BATTERY MAINTENANCE

! WARNING !

- It is the responsibility of the owner of this vehicle to ensure that the service technicians are properly trained, read and obey the safety rules and guidelines in this manual (ANSI B56).
- Maintenance operations must be made by properly trained service technicians only.
- Before any maintenance work, park the vehicle on a flat level surface, turn off all the switches, set to neutral, remove the key, lift the wheels off the ground and secure with jack stands of adequate capacity.
- Keep charger disconnected while doing any maintenance work.
- Always wear a face shield and scarf when working around batteries.
- Battery emits highly explosive gases; do not produce sparks to avoid battery explosion and acid splashing. Battery acid causes severe damage to eyes or skin. Flush contaminated area immediately with water.
- Use insulated tools to avoid sparks that can cause battery explosion and acid splashing.
- Use two counteracting tools, double-wrench technique, when disconnecting or tightening battery posts.
- Before cleaning or replacing a battery, discharge the capacitor in the controller with a 10 ohms, 25 W resistor for a few seconds across B+ and B-, identify battery polarity and disconnect battery leads.
- After cleaning, the power must not be reapplied until terminal areas are thoroughly dry.

BATTERY LEADS AND CONNECTORS

Check for loose connections, damaged cables, acid spill, loose terminal posts, quarterly.

BATTERY POST CORROSION

If corrosion is present on battery posts, remove the cable connectors, use a wire brush to remove particles, and then clean them with a cloth that has been moistened with ammonia.

ELECTROLYTE LEVEL

Does not apply to sealed battery.

- Disconnect battery connectors on roll-out or lift-out installations.
- Make sure the battery roll-out tray is provided with stops before rolling out.
- Fill with distilled water.
- Daily charged batteries normally require watering once a week. Under watering leads to a shortened battery life. Over watering leads to battery corrosion. Be careful not to overfill any cell to avoid electrolyte to be forced out while charging.
- Fill each cell to plate level with distillated or de-ionized water, before battery charging. When the battery is charged, the fluid expands and can seep out if overfilled. Refill each cell after full charge, when the fluid has expanded to its maximum level.
- Reinstall battery caps before charging.

BATTERY MOUNTING

A loose battery increases damaging effects of vibrations and is more prone to short out.

BATTERY DISCHARGE LIMIT

Discharging below a 20% state of charge cuts down the battery life and the number of cycles available. At 20% state of charge, specific gravity of 6V battery should be 1180; and 1220 for industrial battery.

CHARGING AREA

- Always charge battery in a well ventilated area set for and approved for charging.
- Never leave a charger connected for more than 20 hours.

FREQUENCY OF CHARGE

- When a battery is discharged to its 20% state of charge, it is best to charge immediately.
- Batteries require a low current equalization charge (min 4 hours) at least every week, to equalize battery cells, improve battery performance and life in number of cycles.
- Never leave a charger connected for more than 20 hours.

STORAGE

- Keep the battery from getting cold, it would loose its capacity.
- Let the battery warm up before charging.
- Charge batteries in “stored” vehicles every month.

DEFECTIVE BATTERY

Check specific gravity of each cell; if a cell is shorted, voltage drop may occur only when there is current.

BATTERY CHARGER

! WARNING !

Always unplug the AC and DC electrical cords before attempting any repairs to the charger.

CHARGER DOES NOT TURN ON:

- Dc cord of portable chargers must be disconnected from batteries after every charge to restart;
- Check dc fuse links;
- Check battery voltage at the battery connector;
- Check ac outlet and cordset;
- Replace electronic control ;

RELAY CLOSES AND TRANSFORMER HUMS BUT AMMETER DOES NOT REGISTER:

- Check dc fuse links;
- Check the continuity of the dc output cord, ammeter, diodes and all connections in the dc circuit;
- Check diodes;
- Check capacitor(rapidely increasing resistance);

SINGLE CHARGER FUSE BLOWS:

- Disconnect and check diodes;

BOTH FUSE LINKS BLOW:

- Check the battery pack and battery connector polarity;
- Disconnect and check diodes.

CHARGER OUTPUT IS LOW:

- Disconnect and check diodes;
- Can be caused by a transformer failure.

AMMETER READS 30 AMPS FOR MORE THAN 30 MINUTES:

- Check the battery pack;

CHARGER DOES NOT TURN OFF:

- Check specific gravity in each battery cell;
- As much as 16 hours may be required to properly charge heavely discharged new or cold batteries;
- Replace electronic control.

AC LINE FUSE OR CIRCUIT BREAKER BLOWS:

- Check ac cordset;
- Check ac line fuse rating;
- Replace electronic control;
- Can be caused by a transformer failure.

ELECTRICAL TROUBLESHOOTING

! WARNING !

Maintenance work must be performed by trained service technicians only.

It is the responsibility of the owner of this vehicle to ensure that the services technicians are properly trained, understand and obey the safety rules and guidelines (ANSI B56).

All service technicians must read and understand the maintenance warning section in this manual.

! WARNING !

Before any maintenance work, park the vehicle on a flat level surface, turn off all switches, remove the key, lift the wheels off the ground, secure with jack stands of adequate capacity, disconnect charger.

Always wear safety glasses.

Batteries emit highly explosive gases that can be ignited by a spark. Before disconnecting a high current terminal, turn off all switches, disconnect battery charger, disconnect batteries.

Keep clear from moving parts such as tires, sheaves and motor.

PMC SELF DIAGNOSTIC

If your PMC comes with a status led, use the flashing code to help troubleshooting.

BATTERY VOLTAGE

Make sure batteries are securely connected. Measure voltage between + and - terminals. We will call this value B+ or full battery voltage.

ACCESSORIES NOT WORKING

- Check the fuses on the batteries and the DC/DC converter.
- Check voltage across + and – terminals on the battery gage; if not B+, check wiring.
- Turn the key switch ON, check voltage between output terminal on the key switch and the - terminal on the battery gage; if not B+, replace the key switch.
- Check voltage across DC/DC converter output terminals; if not 12-Volt, replace the converter.
- Depress the accessory switch, check voltage across accessory terminals. If not 12-Volt, replace the switch. If 12-Volt, replace the accessory.

FORWARD ONLY

On a SEPEX motor control, check the reverse signal input on the controller.
On a series wound motor control, a bad reverse contactor is the most probable cause of the problem. Switch to reverse and check voltage on the reverse control wire. If not B+, replace the F/R switch. If B+, turn off the key switch, disconnect batteries, disconnect power terminals on the F/R contactors, check the resistance across N.C. power terminals of the reverse contactor. If not 0 ohm, change the reverse contactor. If 0 ohms, switch to forward and check the resistance across the forward N.O. power terminals. If not 0 ohms, change the forward contactor.

REVERSE ONLY

On a SEPEX motor control, check the forward signal input on the controller.
On a series wound motor control, a bad forward contactor is the most probable cause of the problem. Switch to forward and check the voltage on the forward control wire. If not B+, replace the F/R switch. If B+, turn off the key switch, disconnect batteries, disconnect power terminals on the F/R contactors, check the resistance across N.C. power terminals of the forward contactor. If not 0 ohm, change the forward contactor. If 0 ohms, switch to reverse and check the resistance across the reverse N.O. power terminals. If not 0 ohms, change the reverse contactor.

TRAVEL AT REDUCED SPEED

Check batteries.

Turn off all switches and disconnect charger. Wear face shield and gloves. Do not disturb any battery connection to avoid sparks. Check the specific gravity of each cell. Cold batteries, highly discharged batteries or dead cells are the most frequent causes of reduced travel speed.

Check potentiometer.

Turn off the key switch, disconnect potentiometer terminals. Check the resistance between terminals.

Other causes of lower speed:
- dragging brakes;
- cold temperature (higher differential oil viscosity).

INTERMITTENT OPERATION

A bad potentiometer is the most probable cause of the following:
- acceleration is not constant;
- maximum speed is erratic;
- sudden stop after a bump or shock;
- erratic starts, requiring several pedal cycles.

A bad F/R contactor is also a probable cause of the following:
- sudden stop after a bump or shock;
- would not start to move at times.

Erratic starts could also be the cause of a misadjusted potentiometer or micro-switch; the pot signal must be less than 50 ohms when the micro-switch turns on.

PMC has an HPD safety feature that prevents the vehicle from moving if the accelerator pedal is depressed before the key switch is ON and seat switch is activated.

PMC may also have an SRO safety feature that prevents the vehicle from moving if the F/R switch is activated before turning on the key switch and activating the seat switch.

The vehicle stops on a steep and long ramp or while towing a heavy load: the circuit breaker has open to prevent motor overheating and will reset automatically after one minute. The PMC is also equipped with an internal thermal protection that cutback the current until the PMC has cooled down.

NO MOTION

Make sure that the PMC surface is clean and dry; check the terminal areas. Dust Particles or acid contamination, can create current leaks and cause a PMC malfunction.

Check F/R switch

Turn on the key switch and set to forward. Check voltage between the forward terminal and the – terminal on the battery gage, check voltage between the reverse terminal and the – terminal on the battery gage; if both B+, replace the F/R switch.

Check switches and wiring

Disconnect control terminals on the PMC and check all control signals. If a switch pin does not read B+, check wiring or replace the switch.

Check potentiometer

Turn the key switch to OFF, disconnect potentiometer terminals. Check the resistance across terminals: if not within the recommended limits, adjust or replace the potentiometer. Check for shorts between potentiometer wires and vehicle frame; resistance should read at least 1 megohm.

Check main contactor or solenoid

Check voltage across power terminals; if not B+, check circuit breaker or replace the solenoid.
Turn to on the key switch and activate the seat switch. Check voltage across the coil terminals; if not B+, check wiring and interlock switches. Check resistance across power terminals; if not 0 ohms, replace the solenoid.

Check circuit breaker and SEPEX DIODE

Before replacing the circuit breaker, check for shorts in the power circuit and check the SEPEX diode in the power circuit using a diode tester. If no such instrument is at hand, use an ohmmeter: the reading should be weak in one direction and strong in the other way.
Check the resistance across the circuit breaker. If not 0 ohms, replace the circuit breaker.

Check PMC

First disconnect battery B+ and B-, then PMC B+ and M-. Check the internal diode between B+ and M- terminals using a diode tester. If no such instrument is at hand, use an ohmmeter: the reading should be weak in one direction and strong in the other way. If the internal diode is defective, the PMC must be replaced.

Check the Motor

First disconnect battery B+ and B-, disconnect power terminals and check the motor armature and field for opens.

CURTIS SPEED CONTROLLER

MANUAL

CURTIS PMC

MODEL **1244**

MultiMode™
MOTOR CONTROLLER

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DESIGN OF CURTIS PMC 1200 SERIES CONTROLLERS PROTECTED BY U.S. PATENT NO. 4626750.

1244 Manual, p/n 16958
Rev. B: January 2001

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1244 Manual
p/n 16958, Rev. B: January 2001

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WIRING: Standard Configuration

Figure 3 shows the typical wiring configuration for most applications. The interlock switch is typically a seat switch, tiller switch, or foot switch.

Standard Power Wiring

Motor armature winding is straightforward, with the armature's A1 connection going to the controller's B+ bus bar and the armature's A2 connection going to the controller's M- bus bar.

The motor's field connections (**F1** and **F2**) to the controller are less obvious. The direction of vehicle travel with the forward direction selected will depend on

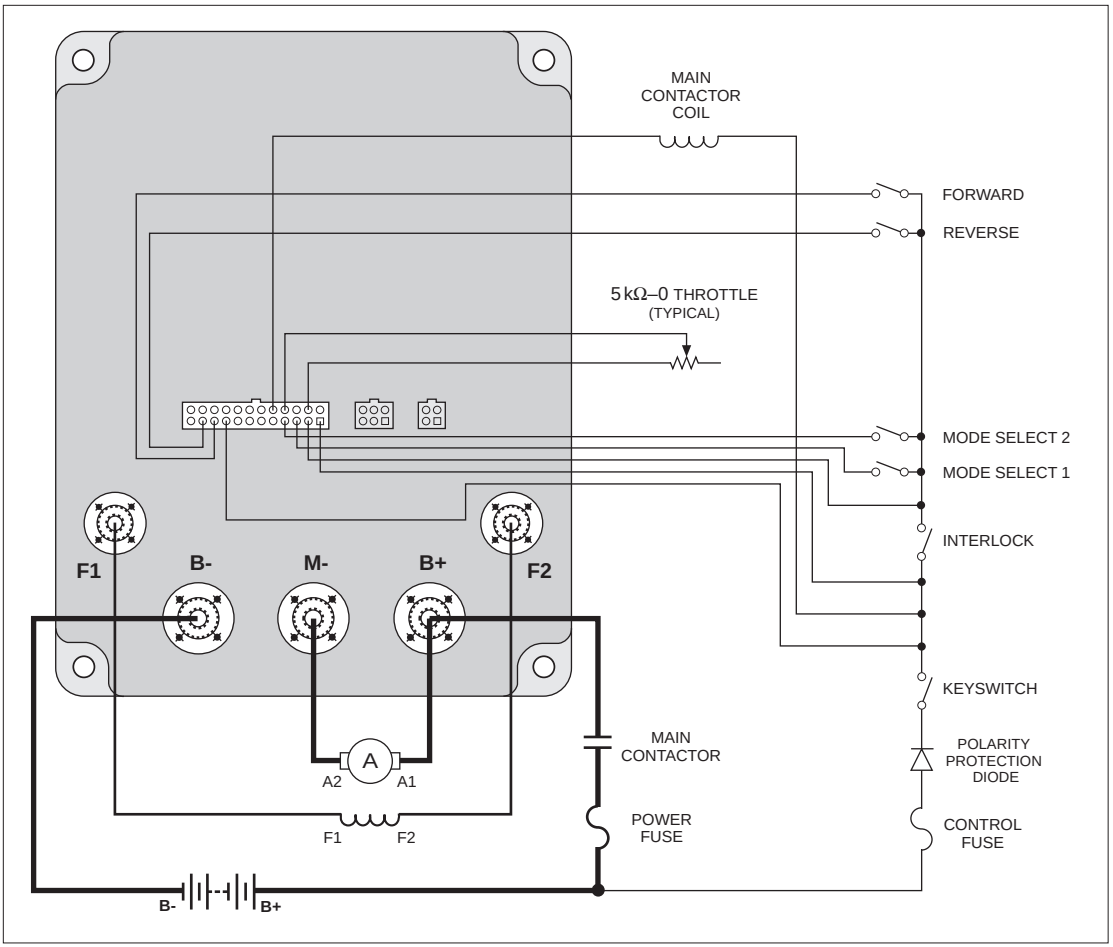


Fig. 3 *Standard wiring configuration, Curtis PMC 1244 controller.*

8 DIAGNOSTICS AND TROUBLESHOOTING

The 1244 controller provides diagnostics information to assist technicians in troubleshooting drive system problems. The diagnostics information can be obtained by observing the appropriate display on the handheld programmer, the fault codes issued by the Status LED, or the fault display driven by the controller's Fault 1 and Fault 2 outputs. Refer to the troubleshooting chart (Table 5) for suggestions covering a wide range of possible faults.

PROGRAMMER DIAGNOSTICS

The programmer presents complete diagnostic information in plain language. Faults are displayed in the Diagnostic Menu (see column 2 in the troubleshooting chart), and the status of the controller inputs/outputs is displayed in the Test Menu.

Accessing the Diagnostic History Menu provides a list of the faults that have occurred since the diagnostic history file was last cleared. Checking (and clearing) the diagnostic history file is recommended each time the vehicle is brought in for maintenance.

The following 4-step process is recommended for diagnosing and troubleshooting an inoperative vehicle: (1) visually inspect the vehicle for obvious problems; (2) diagnose the problem, using the programmer; (3) test the circuitry with the programmer; and (4) correct the problem. Repeat the last three steps as necessary until the vehicle is operational.

Example: A vehicle that does not operate in "forward" is brought in for repair.

STEP 1: Examine the vehicle and its wiring for any obvious problems, such as broken wires or loose connections.

STEP 2: Connect the programmer, select the Diagnostics Menu, and read the displayed fault information. In this example, the display shows "No Known Faults," indicating that the controller has not detected anything out of the norm.

STEP 3: Select the Test Menu, and observe the status of the inputs and outputs in the forward direction. In this example, the display shows that the forward switch did not close when "forward" was selected, which means the problem is either in the forward switch or the switch wiring.

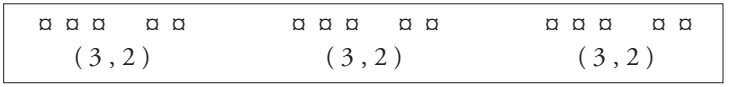
STEP 4: Check or replace the forward switch and wiring and repeat the test. If the programmer shows the forward switch closing and the vehicle now drives normally, the problem has been corrected.

Table 5 TROUBLESHOOTING CHART

LED CODE	PROGRAMMER LCD DISPLAY	FAULT CATEGORY	EXPLANATION	POSSIBLE CAUSE
1,2	HW FAILSAFE1-2-3	1	self-test or watchdog fault	1. Controller defective.
1,3	M- SHORTED	1	internal M- short to B-	1. Controller defective.
	FIELD OPEN	1	field winding fault	1. Motor field wiring loose. 2. Motor field winding open.
	ARM SENSOR	1	armature current sensor fault	1. Controller defective.
	FLD SENSOR	1	field current sensor fault	1. Controller defective.
2,1	THROTTLE FAULT 1	1	wiper signal out of range	1. Throttle input wire open. 2. Throttle input wire shorted to B+ or B-.
	THROTTLE FAULT 2	1	pot low fault	1. Throttle pot defective. 2. Wrong throttle type selected.
2,2	SRO	3	SRO fault	1. Improper sequence of KSI, interlock, and direction inputs. 2. Wrong SRO type selected. 3. Interlock or direction switch circuit open. 4. Sequencing delay too short.
2,3	HPD	3	HPD fault	1. Improper seq. of direction and throttle inputs. 2. Wrong HPD type selected. 3. Misadjusted throttle pot. 4. Sequencing delay too short.
2,4	BB WIRING CHECK	1	emergency reverse wiring fault	1. Emergency reverse wire open. 2. Emergency reverse check wire open.
3,1	CONT DRVR OC	1	cont. driver output overcurrent	1. Contactor coil shorted.
3,2	MAIN CONT WELDED	1	welded main contactor	1. Main contactor stuck closed. 2. Main contactor driver shorted.
3,3	PRECHARGE FAULT	1	internal voltage too low at startup	1. Controller defective. 2. External short, or leakage path to B- on external B+ connection.
3,4	MISSING CONTACTOR	1	missing contactor	1. Any contactor coil open or not connected.
	MAIN CONT DNC	1	main contactor did not close	1. Main contactor missing or wire to coil open.
4,1	LOW BATTERY VOLTAGE	2	low battery voltage	1. Battery voltage <undervoltage cutback limit. 2. Corroded battery terminal. 3. Loose battery or controller terminal.
4,2	OVERVOLTAGE	2	overvoltage	1. Battery voltage >overvoltage shutdown limit. 2. Vehicle operating with charger attached. 3. Battery disconnected during regen braking.
4,3	THERMAL CUTBACK	2	over-/under-temp. cutback	1. Temperature >85°C or < -25°C. 2. Excessive load on vehicle. 3. Improper mounting of controller. 4. Operation in extreme environments.
4,4	ANTI-TIEDOWN	3	Mode 2 or Mode 4 selected at startup	1. Mode switches shorted to B+. 2. Mode switches “tied down” to select Mode 2 or Mode 4 permanently.

LED DIAGNOSTICS

A Status LED is built into the 1244 controller. It is visible through a window in the label on top of the controller. This Status LED displays fault codes when there is a problem with the controller or with the inputs to the controller. During normal operation, with no faults present, the Status LED flashes steadily on and off. If the controller detects a fault, a 2-digit fault identification code is flashed continuously until the fault is corrected. For example, code "3,2"—welded main contactor—appears as:



The codes are listed in Table 6.

Table 6 STATUS LED FAULT CODES

LED CODES		EXPLANATION
LED off	▬▬▬	no power or defective controller
solid on	▭	controller or microprocessor fault
0,1	■ ¤	controller operational; no faults
1,1	¤ ¤	[not used]
1,2	¤ ¤¤	hardware failsafe fault
1,3	¤ ¤¤¤	M-, current sensor, or motor fault
1,4	¤ ¤¤¤¤	[not used]
2,1	¤¤ ¤	throttle fault
2,2	¤¤ ¤¤	static return to off (SRO) fault
2,3	¤¤ ¤¤¤	high pedal disable (HPD) fault
2,4	¤¤ ¤¤¤¤	emergency reverse circuit check fault
3,1	¤¤¤ ¤	contactor driver overcurrent
3,2	¤¤¤ ¤¤	welded main contactor
3,3	¤¤¤ ¤¤¤	precharge fault
3,4	¤¤¤ ¤¤¤¤	missing contactor, or main cont. did not close
4,1	¤¤¤¤ ¤	low battery voltage
4,2	¤¤¤¤ ¤¤	overvoltage
4,3	¤¤¤¤ ¤¤¤	thermal cutback, due to over/under temp.
4,4	¤¤¤¤ ¤¤¤¤	anti-tiedown fault

NOTE: Only one fault is indicated at a time, and faults are not queued up. Refer to the troubleshooting chart (Table 5) for suggestions about possible causes of the various faults.

PROGRAMMING PARAMETERS – E-280B, E-290, E-360, T-236, T-236D

! WARNING !

The owner of this vehicle shall ensure that the service technicians are qualified, properly trained and obey the safety rules and guidelines in OSHA and ANSI B56 regulations, and in this manual.

Before installing and/or programming the PMC, park the vehicle on a flat level surface, lift the wheels off the ground and secure with jack stands of adequate capacity. Don't connect charger.

Programmable controllers must be programmed using the parameter settings in this service manual, before connecting the motor, to avoid sudden vehicle movement and accident.

Do not try to increase motor speed by changing parameter settings in the speed controller; it can cause accident and severe damage to the motor.

VOLTAGE	NOMINAL BATTERY VOLTAGE, IN VOLTS	3
M1 DRIVE C/L	MODE 1 DRIVE CURRENT LIMIT, IN AMPS	300
M2 DRIVE C/L	MODE 2 DRIVE CURRENT LIMIT, IN AMPS	300
M3 DRIVE C/L	MODE 3 DRIVE CURRENT LIMIT, IN AMPS	300
M4 DRIVE C/L	MODE 4 DRIVE CURRENT LIMIT, IN AMPS	300
M1 BRAKE C/L	MODE 1 BRAKING CURRENT LIMIT, IN AMPS	150
M2 BRAKE C/L	MODE 2 BRAKING CURRENT LIMIT, IN AMPS	150
M3 BRAKE C/L	MODE 3 BRAKING CURRENT LIMIT, IN AMPS	150
M4 BRAKE C/L	MODE 4 BRAKING CURRENT LIMIT, IN AMPS	150
M1 THRT BRK %	MODE 1 THROT. BRAKING, AS % OF BRAKE C/L	50
M2 THRT BRK %	MODE 2 THROT. BRAKING, AS % OF BRAKE C/L	50
M3 THRT BRK %	MODE 3 THROT. BRAKING, AS % OF BRAKE C/L	50
M4 THRT BRK %	MODE 4 THROT. BRAKING, AS % OF BRAKE C/L	50
M1 ACCEL RATE	MODE 1 ACCELERATION RATE, IN SEC.	4
M2 ACCEL RATE	MODE 2 ACCELERATION RATE, IN SEC.	4
M3 ACCEL RATE	MODE 3 ACCELERATION RATE, IN SEC.	4
M4 ACCEL RATE	MODE 4 ACCELERATION RATE, IN SEC.	4
DECEL RATE	DECELERATION RATE, IN SEC.	2.5
M1 BRAKE RATE	MODE 1 BRAKING RATE, IN SEC.	3
M2 BRAKE RATE	MODE 2 BRAKING RATE, IN SEC.	3
M3 BRAKE RATE	MODE 3 BRAKING RATE, IN SEC.	3
M4 BRAKE RATE	MODE 4 BRAKING RATE, IN SEC.	3
QUICK START	QUICK START THROTTLE FACTOR	1
TAPER RATE	Regen brak. Decrease rate when apporch. 0spd, 1/32s	32
M1 MAX SPEED	MODE 1 MAX. SPEED, AS % PWM OUTPUT	40
M2 MAX SPEED	MODE 2 MAX. SPEED, AS % PWM OUTPUT	100
M3 MAX SPEED	MODE 3 MAX. SPEED, AS % PWM OUTPUT	40
M4 MAX SPEED	MODE 4 MAX. SPEED, AS % PWM OUTPUT	40
M1 CREEP SPEED	MODE 1 CREEP SPEED, AS % PWM OUTPUT	0
M2 CREEP SPEED	MODE 2 CREEP SPEED, AS % PWM OUTPUT	0
M3 CREEP SPEED	MODE 3 CREEP SPEED, AS % PWM OUTPUT	0
M4 CREEP SPEED	MODE 4 CREEP SPEED, AS % PWM OUTPUT	0
REGEN SPEED	Min. speed for regen braking, as % of vehicle speed	25
CTRL MODE	CONTROL MODE	1
THROTTLE TYPE	THROTTLE TYPE	3

THRO. DEADBAND	Thr. Neutral deadband % of 5kohms pot	6
THROTTLE MAX	Thr. Input req`d for 100%PWM %5kohm pot	90
M1 THRTL MAP	MODE 1 THROTTLE MAP, AS %	30
M2 THRTL MAP	MODE 2 THROTTLE MAP, AS %	30
M3 THRTL MAP	MODE 3 THROTTLE MAP, AS %	30
M4 THRTL MAP	MODE 4 THROTTLE MAP, AS %	30
FIELD MIN	MIN. FIELD CURRENT, IN AMPS	7
FIELD MAX	MAX. FIELD CURRENT, IN AMPS	30
FIELD MAP START	Armature current at wich FIELD MAP takes effect, amps	70
FIELD MAP	Field Winding Current, as % of Armature Current	50
CURRENT RATIO	CURRENT RATIO:FACTOR OF 1, 2, 4 OR 8	1
RESTRAINT	RAMP RESTRAINT: 1 TO 10	3
LOAD COMP	LOAD COMPENSATION: 0 TO 25	0
HPD	HIGH PEDAL DISABLE (HPD) TYPE	1
SRO	STATIC RETURN TO OFF (SRO) TYPE	1
SEQUENCING DLY	SEQUENCING DELAY, IN SEC.	1
MAIN CONT INTR	MAIN CONTACTOR INTERLOCK: ON OR OFF	ON
MAIN OPEN DELAY	MAIN CONTACTOR DROPOUT DELAY, IN SEC.	1
WELD CHECK	MAIN CONTACTOR WELD CHECK: ON OR OFF	ON
MAIN CHECK	MAIN COIL OPEN CHECK: ON OR OFF	ON
AUX ENABLE	AUXILIARY ENABLE: ON OR OFF	OFF
EM BRAKE	ELECTROMAGNETIC BRAKE ON OR OFF	OFF
AUX DELAY	AUXILIARY DRIVER DROPOUT DELAY, IN SEC.	0
AUX CHECK	AUXILIARY COIL OPEN CHECK: ON OR OFF	OFF
EM BRAKE DELAY	ELECTROMAGNETIC BRAKE DELAY, IN SEC.	0
EM BRAKE CHECK	ELECTROMAG. BRAKE OPEN CHECK: ON OR OFF	OFF
REV DRVR CHECK	REVERSE SIGNAL OPEN CHECK: ON OR OFF	OFF
CONT PULL IN	CONTACTOR COIL PULL-IN VOLTAGE, AS %	100
CONT HOLDING	CONTACTOR HOLDING VOLTAGE, AS %	100
EMR REV ENABLE	EMERGENCY REVERSE FUNCTION : ON OR OFF	OFF
EMR REV C/L	EMERGENCY REVERSE CURRENT LIMIT, IN AMPS	50
EMR REC CHECK	EMERGENCY REV. WIRING CHECK : ON OR OFF	OFF
ANTI-TIEDOWN	ANTI-TIEDOWN: ON OR OFF	OFF
FAULT CODE	ON OR OFF	ON
PEDAL INTERLOCK	THREADLE, PB-6, CHECK WIRING	OFF
PRECHARGE	ON OR OFF	ON

CURTIS PMC MOTOR CONTROLLER

MANUAL

CURTIS PMC

1204X/1205X and 1209/1221

MOTOR CONTROLLERS

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DESIGN OF CURTIS PMC 1200 SERIES CONTROLLERS PROTECTED BY U.S. PATENT NO. 4626750.

1204X / 1205X / 1209 / 1221 Manual
p/n 98796, Rev. D: May 1999

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1

OVERVIEW

Curtis PMC Model 1204X/1205X and 1209/1221 electronic motor speed controllers are designed to provide smooth, silent, cost-effective control of motor speed and torque on a wide variety of industrial electric vehicles.

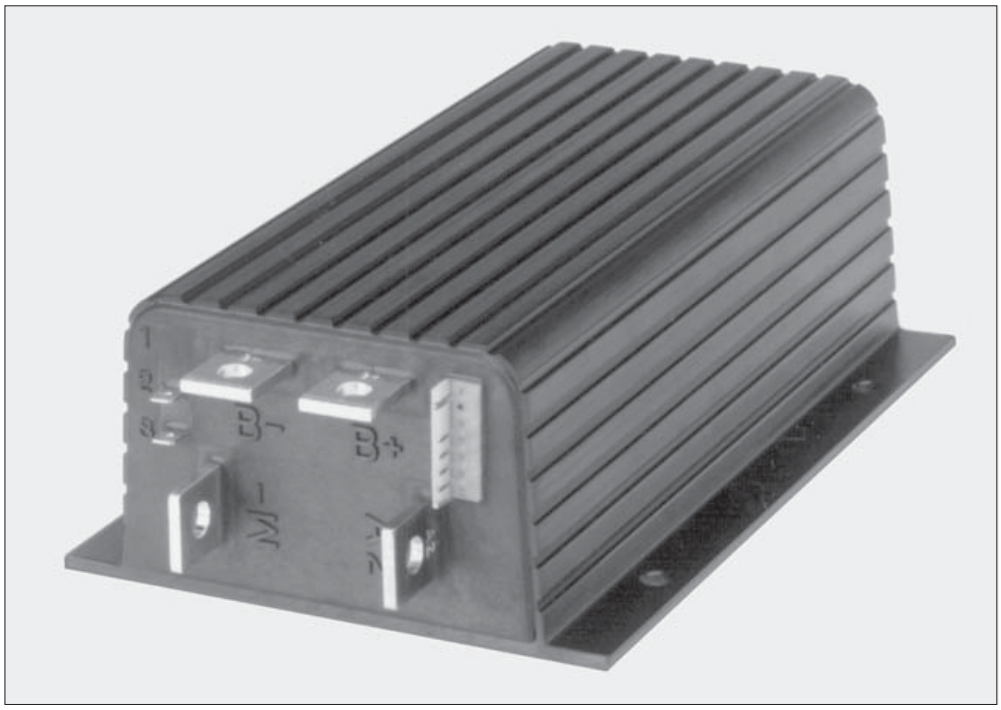


Fig. 1 *Curtis PMC 1205X full-feature electronic motor controller.*

Models 1204X, 1209, and 1221 have identical connections.

Like all Curtis PMC 1200 series controllers, the 1204X/1205X and 1209/1221 models offer superior operator control of the vehicle's motor drive speed. Key features of these controllers include:

- ✓ Infinitely variable drive and brake control
- ✓ Power MOSFET design provides high efficiency (for reduced motor and battery losses) and silent operation
- ✓ High pedal disable (HPD) function monitors throttle status during turn-on and prevents operation until throttle has been returned to neutral *[optional feature]*
- ✓ Thermal protection and compensation circuit provides both under-temperature and overtemperature cutback, as well as steady current limit throughout the entire operating range
- ✓ Undervoltage cutback function protects against low battery voltage, including low voltage caused by external loads

More Features ☞

- ✓ Fault detection circuitry monitors battery, throttle connections, output transistors, bypass contactor, etc., to prevent runaway conditions
- ✓ Static return to off (SRO) function requires that forward or reverse selectors be returned to neutral before output is allowed *[optional feature]*
- ✓ Emergency reverse enhances plugging current when "belly-button" is activated on walkie-type applications *[optional feature]*
- ✓ Delayed bypass (1A) output drives a bypass contactor *[optional feature]*
- ✓ Forward, reverse, and bypass contactor driver outputs are internally protected against shorts in the contactor coils
- ✓ Simple installation with no adjustments required
- ✓ Tin-plated solid copper bus bars
- ✓ Push-on connectors for control wiring

Familiarity with your Curtis PMC controller will help you to install and operate it properly. We encourage you to read this manual carefully. If you have questions, please contact the Curtis office nearest you.

CAUTION

Working on electric vehicles is potentially dangerous. You should protect yourself against runaways, high current arcs, and outgassing from lead acid batteries:

RUNAWAYS — Some fault conditions could cause the vehicle to run out of control. Jack up the vehicle and get the drive wheels off the ground before attempting these procedures or any other work on the motor control circuitry.

HIGH CURRENT ARCS — Electric vehicle batteries can supply very high power, and arcs can occur if they are short circuited. Always open the battery circuit before working on the motor control circuit. Wear safety glasses, and use properly insulated tools to prevent shorts.

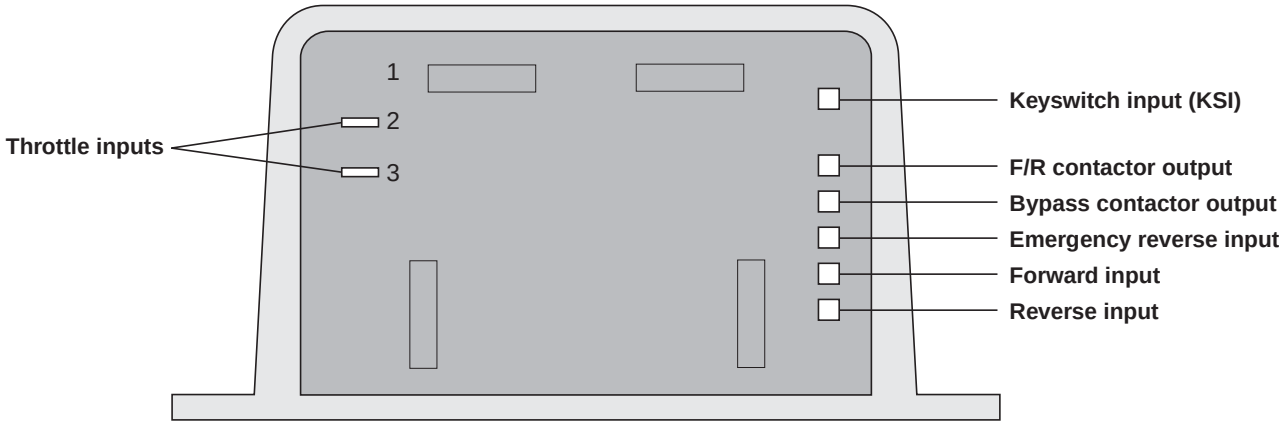
LEAD ACID BATTERIES — Charging or discharging generates hydrogen gas, which can build up in and around the batteries. Follow the battery manufacturer's safety recommendations. Wear safety glasses.

3 WIRING

CONNECTIONS: Low Current

Two 1/4" push-on terminals are provided for the throttle inputs. If your controller has a voltage throttle input, there will be only one throttle terminal.

A 6-pin low power connector molded into the right side of the controller face provides the low power logic control connections—KSI input, forward/reverse contactor output, bypass contactor output *(optional)*, emergency reverse *(optional)*, and forward and reverse inputs.

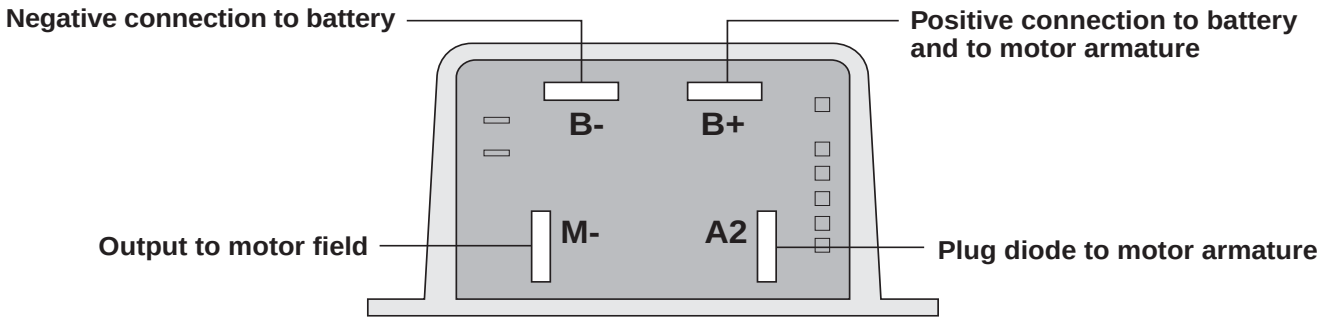


Several manufacturers make mating connectors that fit this connector. The part numbers listed are for the recommended 0.75 mm² (#18 AWG) vinyl insulated stranded wire.

MFR	PART NUMBER	DESCRIPTION
AMP	#640426-7	locking, insulation displacement terminals, wires at right angle to connector
Methode	#3300-107-218	locking, insulation displacement terminals
Molex	#09-50-3071	locking, crimp terminals
Panduit	#CE156F18-7	locking, insulation displacement terminals, wires at right angle to connector

CONNECTIONS: High Current

Four tin-plated solid copper bus bars are provided for the high current connections to the battery and motor.



The cables used for the battery and motor connections must be heavy enough to carry the high current required. Rubber insulated welding cable is convenient to work with because of its flexibility.

Connections to the controller bus bars should be made with lugs suitable for the cable used, fastened by M8 (5/16") bolts and nuts. **When tightening the bolts, two opposing wrenches should be used.** Failure to use the double-wrench technique could cause undue strain to be placed on the internal connections, and could also result in cracked seals around the bus bars.

WIRING: TYPICAL INSTALLATION

Curtis PMC 1204X/1205X/1209/1221 controllers are designed to satisfy the requirements of material handling applications using series motors. Figure 8 is a schematic diagram of the installation shown in Figure 7. Wired this way, the vehicle will plug brake if the direction is changed with the vehicle moving and the throttle applied. Reversing is accomplished via a forward/reverse changeover contactor or two single-pole, double-throw (2×SPDT) contactors. Coil suppression diodes should be used on the main and forward/reverse contactors.

KSI Wiring

The keyswitch input (KSI) circuit includes inputs from the keyswitch and from the various interlocks. The controller KSI is used to turn the controller on and off. KSI is turned on by connecting it to battery B+. Any positive voltage greater than about 8 volts will turn on the controller, but usually the full vehicle battery voltage is used.

In its simplest form, KSI is operated by a keyswitch that turns the vehicle off and prevents unauthorized use. The keyswitch should also turn off the main

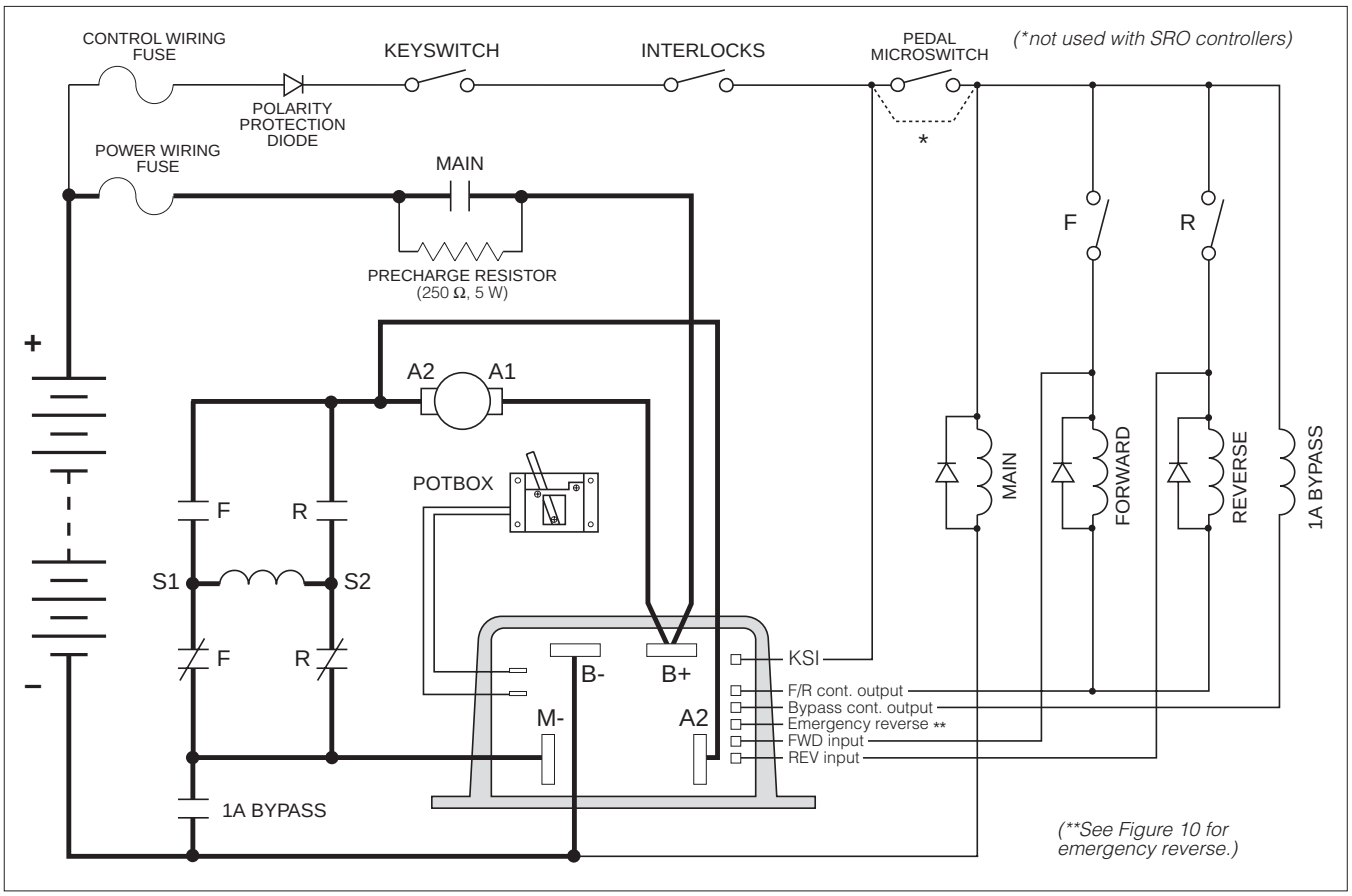


Fig. 8 *Basic wiring configuration, Curtis PMC 1204X/1205X/1209/1221 controllers.*

contactor and the forward/reverse contactors. This will act as a safety feature by removing power from the motor control system when the keyswitch is off.

Interlocks (seat switches, battery charger interlocks, etc.) should be wired in series so that they turn off the controller KSI and the contactors. An SRO interlock (a seat switch, for example) **must** be wired in order to implement the optional SRO feature.

Forward/Reverse Wiring

The forward/reverse wiring schemes described here all assume the power wiring shown by the heavy lines in Figure 8. Some vehicles, especially those previously using older, resistor-type controllers, may reverse the motor armature rather than the field winding. Be careful if you are replacing this type of controller. **When using the Curtis PMC controller it is essential that the field be reversed and that the armature be connected directly to the controller's B+ and A2 terminals, because the plug diode inside is connected to these terminals.**

4 MAINTENANCE & ADJUSTMENT

Curtis PMC 1204X/1205X/1209/1221 controllers and potboxes require only minimal maintenance if properly installed. NOTE: The controllers are sealed and thus are not field serviceable.

CONTROLLER

Maintenance

CAUTION

It is recommended that the following two steps be performed occasionally. **First remove power by disconnecting the battery, and discharge the capacitors in the controller** (with a light bulb or a 2–10 Ω, 25 W resistor connected for a few seconds across B+, B-). Follow good safety practices: get the vehicle drive wheels off the ground, wear safety glasses, and use insulated tools *(see page 2).*

1. Make sure the electrical connections to the controller (and to the motor, contactors, etc.) are tight. When checking the controller bus bar connections for tightness, use two opposing wrenches. This double-wrench technique will help avoid putting stress on the bus bars, which could crack the seals. **Always use insulated wrenches.**

2. Inspect all seals at the front and back of the controller. If necessary, use a moist rag to wipe these areas clean enough so that you can see the seals. Look for cracks and other signs of seal damage.

   If the seals are intact, clean the controller thoroughly either by washing it off or by wiping it clean with a moist rag. **Power must not be reapplied until the controller terminal area is completely dry.**

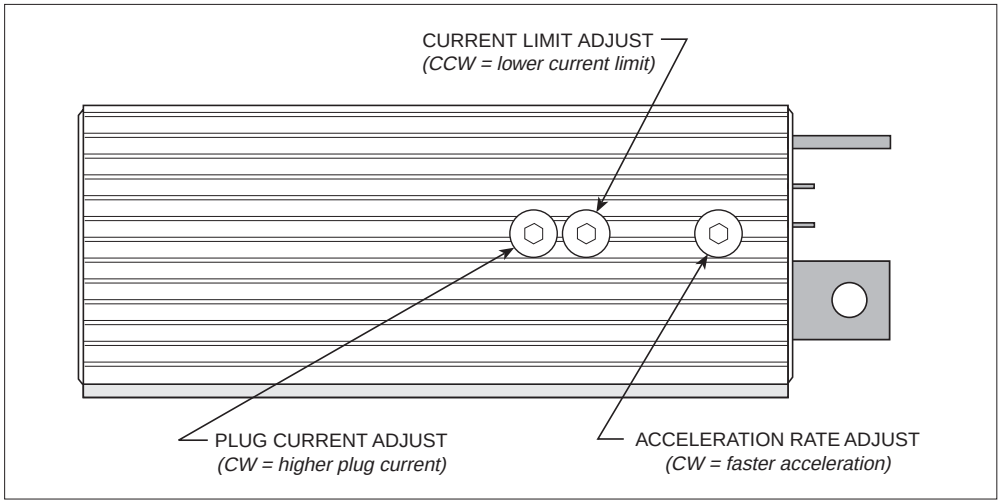
   If the seals have been damaged, there are several possible causes. Perhaps the double-wrench technique was not used when the cables were installed. Perhaps the vehicle's environment requires that the controller be better protected: either by mounting it in a different location, or by installing a protective cover.

   Damaged seals can lead to faulty operation. We strongly recommend replacing controllers that have faulty seals.

Adjustment

Some controllers allow adjustment of the plug braking current, current limit, and acceleration rate settings. The adjustment pots on these models are located as shown in Figure 16.

Fig. 16 *Adjustment pots.*



Use the following adjustment procedure. **The keyswitch should be <u>off</u> during adjustment.**

1. Remove the socket head screw (1/8" Allen) for the adjustment you want to make.

2. Adjust the internal potentiometer using a small **insulated** screwdriver *(available from Curtis).*

3. Replace the socket head screw and nylon seal washer. To prevent stripping, do not over-tighten.

POTBOX

Maintenance

Potbox maintenance is similar to controller maintenance: inspect for integrity of connections and mounting, and clean (with a moist rag) as required.

Adjustment

Curtis PMC potboxes are factory set and rarely require user attention. To test and adjust, connect an ohmmeter to the potbox wires and use this procedure:

1. With the spring holding the lever arm against the return stop, the resistance should be less than 50 ohms. Slowly move the lever. If the resistance abruptly starts to increase when the lever is 3 mm (1/8") from the stop (1.5 mm [1/16"] for potboxes without the microswitch), no adjustment is needed.

2. If adjustment is required, loosen the screw holding the lever on the pot shaft. Use a screwdriver to rotate the pot shaft slightly with respect to the lever. Recheck the point at which the resistance starts to increase and continue making adjustments until the increase starts at 3 mm (1/8") [at 1.5 mm (1/16") for potboxes without the microswitch]. When adjustment is correct, tighten the screw holding the lever on the pot shaft, then recheck to see that this action did not disturb the adjustment. Make sure that the lever is still seated down on the pot shaft below the slight bevel on the end of the shaft.

3. Check the resistance with the lever pushed all the way to the other stop. It should be between 4500 and 5500 ohms. If it is outside this range, the potbox is faulty and should be replaced.

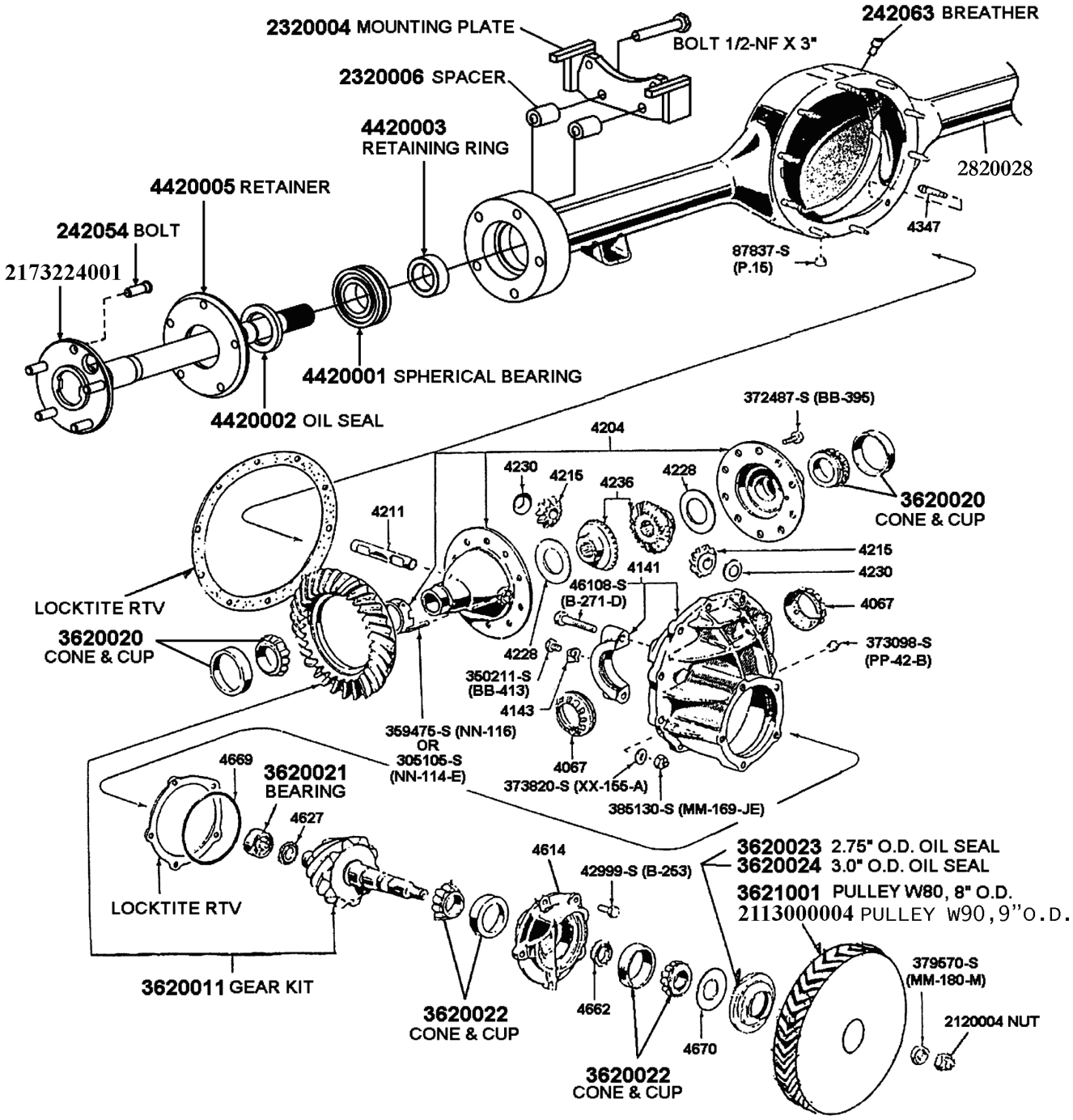
4. For potboxes equipped with a microswitch, check for correct switch operation. Use an ohmmeter, or simply listen for the slight click the switch makes. It should operate when the lever is 1.5 mm (1/16") from the return stop. If it does not, adjust by loosening the two screws holding the slotted microswitch mounting plate to the stop spacers and moving the plate. Recheck the switch operating point after tightening the screws.

SPARE PARTS

BODY

REF.	*PART NO*	*DESCRIPTION*
1	6106280001	BODY
2	120003	TRIM
3	280003	CARGO DECK
4	2800045	DASHBOARD
5	240501	SEAT
	280502	BLACK CLOTH SEAT
5A	1005003	BUCKET SEAT
6	240502	BACKREST SEAT
7	240503	BACKREST FRAME
8	2400036	SEAT SPRING KIT
	2392240003	SEAT SWITCH KIT
9	280101	7” REAR FOOTSTEP
	280107	12” REAR FOOTSTEP
	280108	REAR BUMPER WITH HITCH
	2801008	REAR BUMPER WITH PLATE
10	280105	BAR
11	280106	FRONT BUMPER
12	283001	4.80 X 8 PNEUMATIC WHEEL, 5 BOLT
	283002	4.80 X 8 FOAMFILLED WHEEL, 5 BOLT
	2807001	16” O.D. N.M. SOFT WHEEL, 5 BOLT
13	2800011	LIFT-OUT BOX, NO BATTERY
14	2100021	PLATE, FOOT SWITCH
	2100027	SPACER, FOOT SWITCH

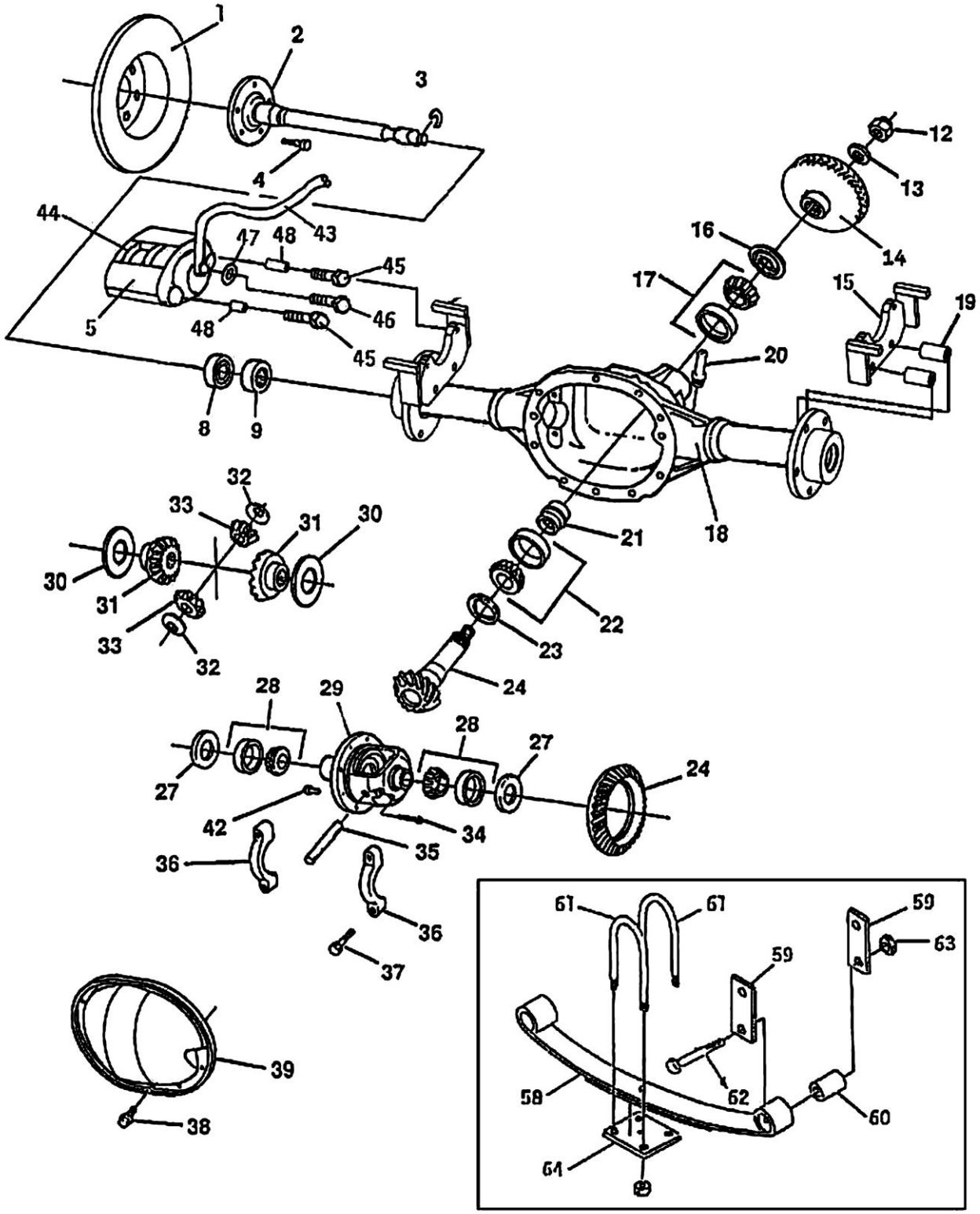
FORD F-150 DIFFERENTIAL



FORD WEC (NON-LOCKING) REAR AXLE SERVICE PARTS LIST NO. 237

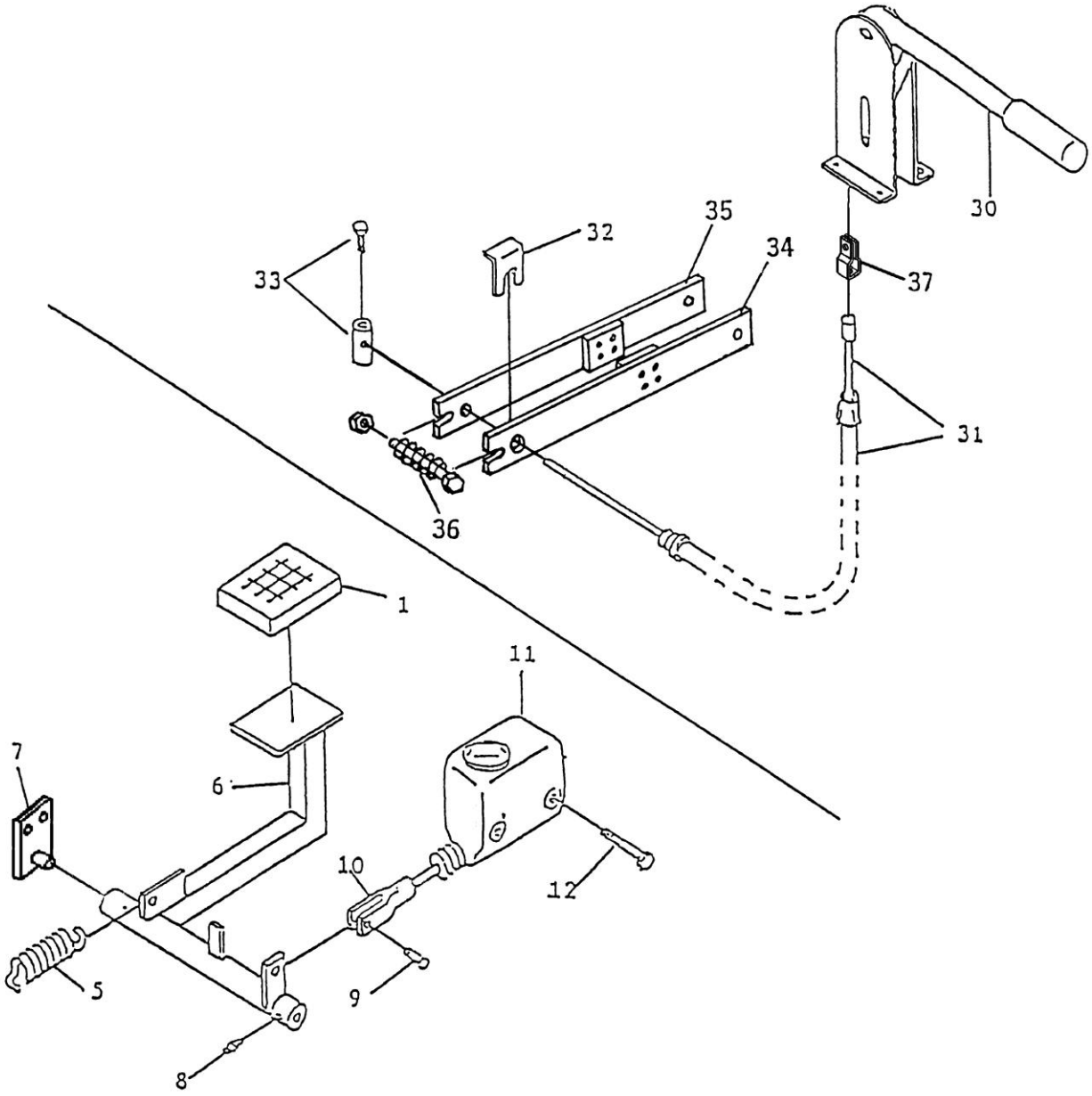
QTY.	PART NUMBER		DESCRIPTION
1	373098-S100 (PP-42-B)		Plug (housing)-1/2"-14
1	E3AZ	4033-A	Cover assy. (housing)-also serviced in assy.-group 4010
		4036	Gasket (cover to housing)-use D8AZ 19562-B
		4067	Shim (differential bearing adjustment)
AR	D9AZ	4067-A	.241" thick
AR	D9AZ	4067-B	.243" thick
AR	D9AZ	4067-C	.245" thick
AR	D9AZ	4067-D	.247" thick
AR	D9AZ	4067-E	.249" thick
AR	D9AZ	4067-F	.251" thick
AR	D9AZ	4067-G	.253" thick
AR	D9AZ	4067-H	.255" thick
AR	D9AZ	4067-J	.257" thick
AR	D9AZ	4067-K	.259" thick
AR	D9AZ	4067-L	.261" thick
AR	D9AZ	4067-M	.263" thick
AR	D9AZ	4067-N	.265" thick
AR	D9AZ	4067-P	.267" thick
AR	D9AZ	4067-R	.269" thick
AR	D9AZ	4067-S	.271" thick
AR	D9AZ	4067-T	.273" thick
AR	D9AZ	4067-U	.275" thick
AR	D9AZ	4067-V	.277" thick
AR	D9AZ	4067-W	.279" thick
AR	D9AZ	4067-X	.281" thick
AR	D9AZ	4067-Y	.283" thick
AR	D9AZ	4067-Z	.285" thick
AR	D9AZ	4067-AA	.287" thick
AR	D9AZ	4067-AB	.289" thick
AR	D9AZ	4067-AC	.291" thick
AR	D9AZ	4067-AD	.293" thick
AR	D9AZ	4067-AE	.295" thick
AR	D9AZ	4067-AF	.297" thick
AR	D9AZ	4067-AG	.299" thick
AR	D9AZ	4067-AH	.301" thick
AR	D9AZ	4067-AJ	.303" thick
AR	D9AZ	4067-AK	.305" thick
AR	D9AZ	4067-AL	.307" thick
		4200	Differential assy.-refer to group in Section 40
		4204	Case assy. (differential)
1	E7TZ	4204-E	Use with axle #720C,724S,730D-1987/
1	E7TZ	4211-A	Shaft (differential pinion kit)-use with axle #720C,724S,730D-1987/ Consists of 1-E7TW 4211-AA Shaft 1-D8BZ 4241-A Pin
1	E7TZ	4215-A	Pinion kit-use with axle #720C,724S, 730D-1987/ Consists of 2-E7TW 4215-AA Pinion 2-E7TZ 4230-A Washer
10	D5AZ	4216-A	Bolt (differential case)-self-locking-7/16"-20 x 3/4"
2	B7A	4221-B	Cone and roller (differential bearing)-#LM603049
2	D9AZ	4222-A	Cup (differential bearing)-#LM603012
		4228	Washer (differential side gear thrust)-also serviced in kit-group 4236
2	E7TZ	4228-A	Use with axle #720C,724S,730D-1987/
		4230	Washer (differential pinion thrust)-also serviced in kit-group 4215
2	E7TZ	4230-A	Use with axle #720C,724S,730D-1987/
1	E7TZ	4236-A	Gear kit (differential side)-use with axle #720C,724S,730D-1987/ Consists of 2-E7TZ 4228-A Washer 2-E7TW 4236-AA Gear
2	C7AZ	4N237-A	"U" washer (axle shaft retaining)
1	D8BZ	4241-A	Pin (differential pinion shaft lock)
2	C7AZ	4A332-A	"O" ring (axle shaft)
		4346	Bolt (housing cover)-self-locking-5/16"-18 x 5/8"-also serviced in assy.-group 4010
10	E6TZ	4346-A	Use with axle #WEC-A,B,720C,724S,730D,760B, 762T
8	E6TZ	4346-A	Use with axle #760C,762P
2	E5TZ	4346-A	Stud (housing cover)-5/16"-18 and-5/16"-18 x 1 1/2" long-also serviced in assy.-group 4010-use with axle #760C,762P
1	B7A	4616-A	Cup (driving pinion bearing front)-#88048
1	B7A	4621-A	Cone and roller (drive pinion front bearing)-#M88048
1	C7AZ	4628-A	Cup (driving pinion bearing-rear)-#M802011
1	C7AZ	4630-A	Cone and roller (drive pinion rear bearing)-#M802048
1	B7A	4662-A	Spacer (driving pinion bearing)-1 5/16" I.D. x 15/32" long-collapsible-also serviced in kit-group 4209
		4663	Shim (pinion bearing)-serviced only in kit-group 4209
1	D5AZ	4670-A	Slinger (pinion shaft oil)
1	E5DZ	4676-A	Seal assy. (drive pinion oil)-#E5DW 4676-AA
		4851	Flange assy. (universal joint)-axle end
1	E7UZ	4851-A	1330 size-1987/
1	389546-S100 (MM-170-A)		Locknut and washer assy. (flange to pinion)-3/4"-20-also serviced in kit-group 4209
		4859	Deflector (driving pinion oil seal)
1	E6TZ	4859-A	Plastic-"From 1/86"-1986/

DIFFERENTIAL AND REAR SUSPENSION



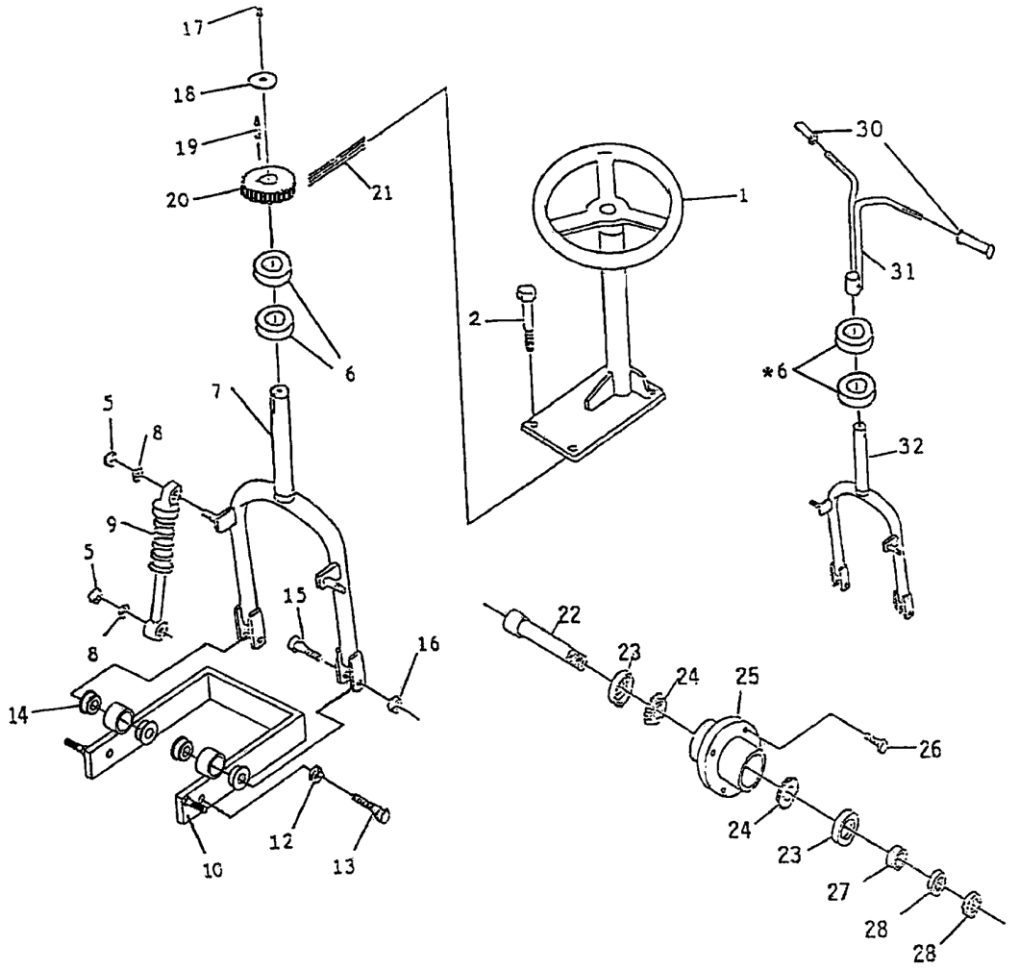
REF.	*PART NO*	*DESCRIPTION*	*REF.*	*PART NO*	*DESCRIPTION*
1	481433	DISC (HYDRAULIC BRAKE)	31	242073	GEAR KIT
2	2173236001	REAR AXLE	32	242074	WASHER
3	242053	LOCK	33	3620027	GEAR KIT
4	242054	WHEEL STUD	34	242076	SCREW
5	481430K	LEFT CALIPER	35	3620006	SHAFT
	481431K	RIGHT CALIPER	36	242078	CAP
	481430RK	REPAIRE KIT, CALIPER	37		BOLT
8	2420011	OIL SEAL	38	242079	DRAIN PLUG
9	2420010	NEEDLE BEARING	39	242080	DIFFERENTIAL COVER
12	242058	NUT	42	2420019	BOLT
13	242059	FLAT WASHER	43	481432	BRAKE HOSE FOR DISC BRAKE
14	2113000002	PULLEY W90	44	2814003	BRAKE PADS
15	2122236001	MOUNTING PLATE (CALIPER)	45	481434	BOLT, LONG
16	242060	OIL SEAL		481442	BOLT, SHORT
17	242061	TAPERED BEARING	46	481440	HYDRAULIC BOLT
18	2820005	HOUSING	47	481441	WASHER
19	2320006	SPACER	48	3614002	BUSHING, LONG
20	242063	BREATHER		3614003	BUSHING, SHORT
21	242064	SPACER	58	4840001	LEAF SPRING (4000 Lbs CAP.)
22	242065	TAPERED BEARING	59	481439	SHACKLE
23	242066	SHIM	60	2183240002	BUSHING
24	242067	GEAR KIT	61	2840007	U-BOLT, 2 ¾ I.D.
27	242069	SHIM		2820008	U-BOLT, 3 ¼ I.D.
28	242070	TAPERED BEARING	62		BOLT 5/8-NC X 3-½
29	242071	CASE	63		LOCK NUT 5/8-NC
30	242072	WASHER	64	2840003	PLATE

BRAKE CONTROLS



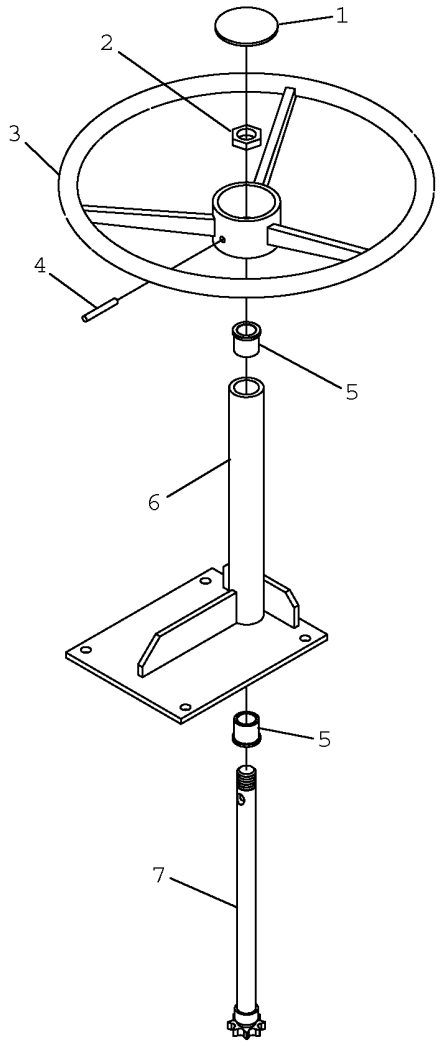
REF	*PART NO*	*DESCRIPTION*	*QTY*	*REF*	*PART NO*	*DESCRIPTION*	*QTY*
1	242801	Rubber	1	30	3616013	8 in. Handbrake lever	1
5	242816	Spring	1	31	362831	Cable	1
6	2416006	Lever	1	32	362832	Clip	1
7	242831	Pivot	2	33	362833	Cable stop	1
8	242817	Lubrication fitting	1	34	3616014	Handbrake band (cable side)	1
9		Clevis pin 3/8 x 1	1	35	3616012	Handbrake band	1
10	122813	Yoke	1	36	3616015	Spring 20 lbs.	1
11	362805	Master cylinder	1	37	2416009	Yoke	1
12		Bolt 3/8-NC x 3	2				

STEERING ASSEMBLY



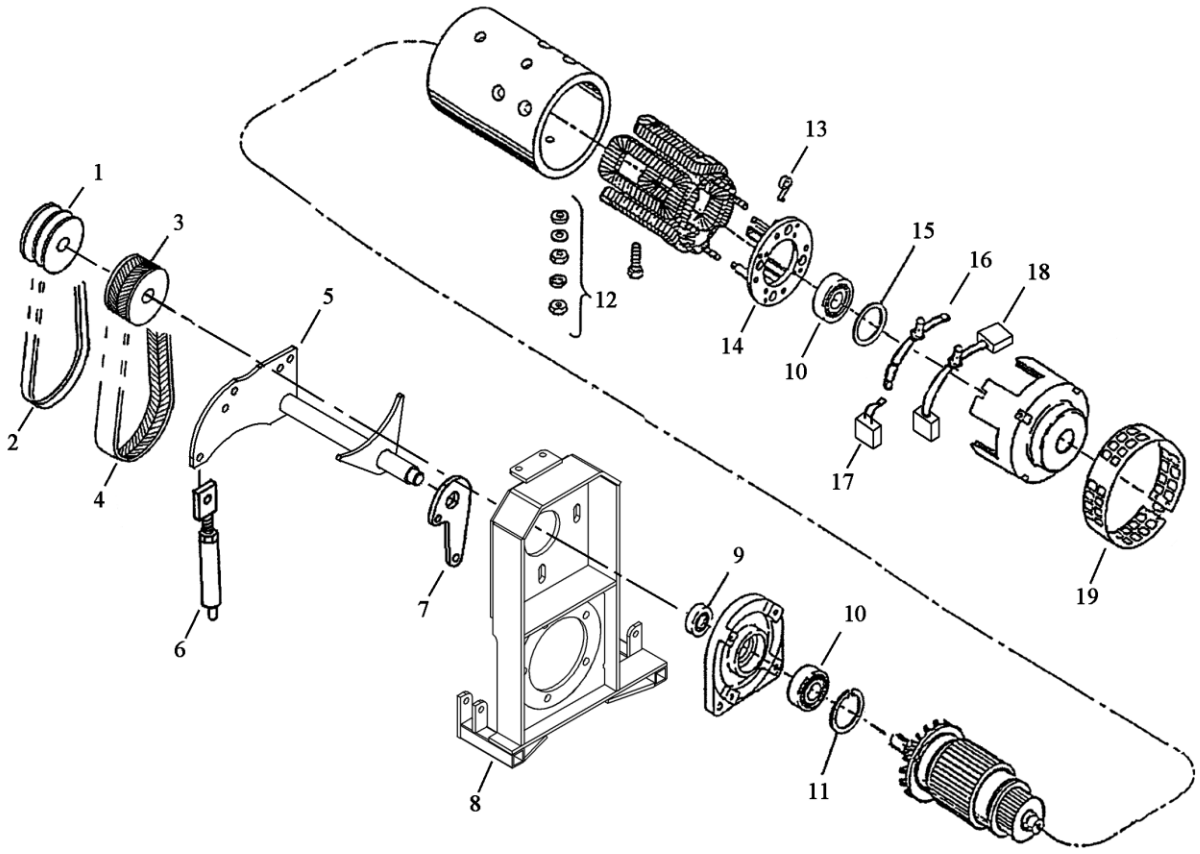
REF.	*PART NO*	*DESCRIPTION*	*REF.*	*PART NO*	*DESCRIPTION*
1	241430	STEERING WHEEL ASS.	**20**	241431	SPROKET
2		BOLT 3/8-NC X 3	**21**	2430010	CHAIN
5		LOCKNUT 7/16-NC	**22**	241001	AXLE
6	241406	BALL BEARING (2.44 O.D.)	**23**	241002	SEAL
	281406	BALL BEARING (3.31 O.D.)	**24**	241003	TAPER BEARING
7	241427	FORK (2.44 BEARING O.D.)	**25**	241004	HUB, 4 BOLT
	281427	FORK (3.31 BEARING O.D.)		281004	HUB, 5 BOLT
9	281409	SHOCK ABSORBER	**26**	241005	WHEEL BOLT
10	281410	SUSPENSION ARM	**27**	241006	BUSHING
12		LOCK WASHER ½	**28**		JAM NUT 1-14-NF
13		BOLT ½-NF X 1 ½	**30**	241402	HANDGRIPS, RIGHT & LEFT
14	2440007	NYL-OIL ½ BUSHING, SET FOR 4	**31**	241401	HANDLE BAR
15		BOLT 5/8-NC X 3	**32**	241407	FORK (2.44 BEARING O.D.)
16		LOCKNUT 5/8-NC		281407	FORK (3.31 BEARING O.D.)
17		BOLT ¼-NC X ¾	**33**		BOLT 3/8-NC X ¾
18	261405	FLAT WASHER			
19		KEY ¼			

STEERING WHEEL



REF.	*PART NO*	*DESCRIPTION*
	241430	STEERING WHEEL ASS.
1	481453	COVER
2	481452	NUT
3	481451	STEERING WHEEL
4	481454	SPRING PIN
5	481437	BUSHING
6	2830011	SUPPORT
7	2830004	SHAFT

MOTOR AND DRIVE



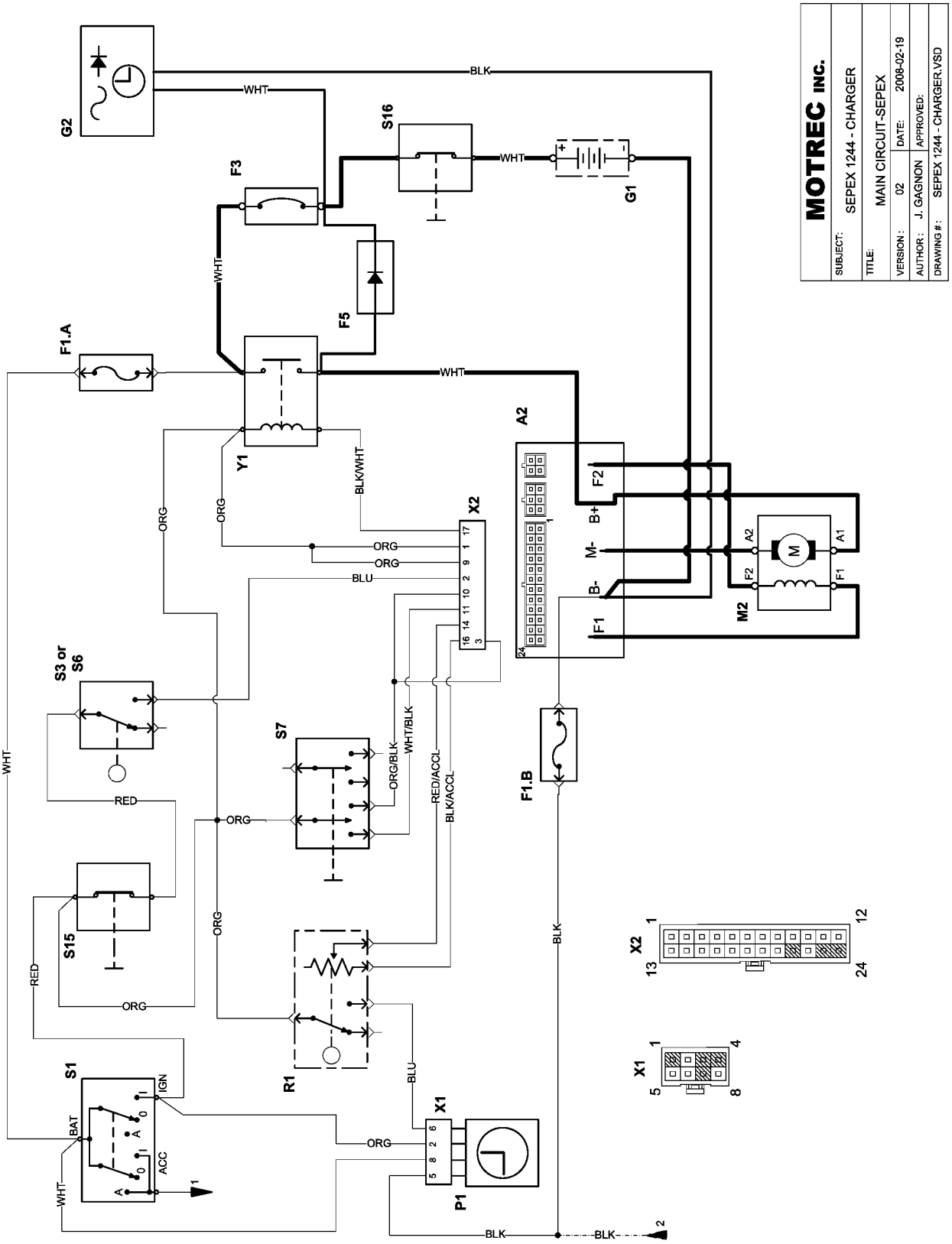
COMMON PARTS

REF	*DESCRIPTION*	*PART #*	*REF*	*DESCRIPTION*	*PART #*
1	PULLEY	262424	8	MOTOR BASE, FORD	Contact manuf.
2	V BELT	242431		BELT TENSIONER	2152002
3	PULLEY	3651001	9	SEAL	484001
4	BELT, EAGLE	3651002	10	BEARING	484003
5	MOTOR BASE, GM	Contact manuf.	11	SNAP RING	484004
6	BELT TENSIONER, LONG	2452005	12	NUT WASHER PACK	484006
	BELT TENSIONER, SHORT	2452003	15	WAVY WASHER	484013
7	PIVOT	2452002	19	HEADBAND	484015
				EE HEADBAND KIT	A91-107A

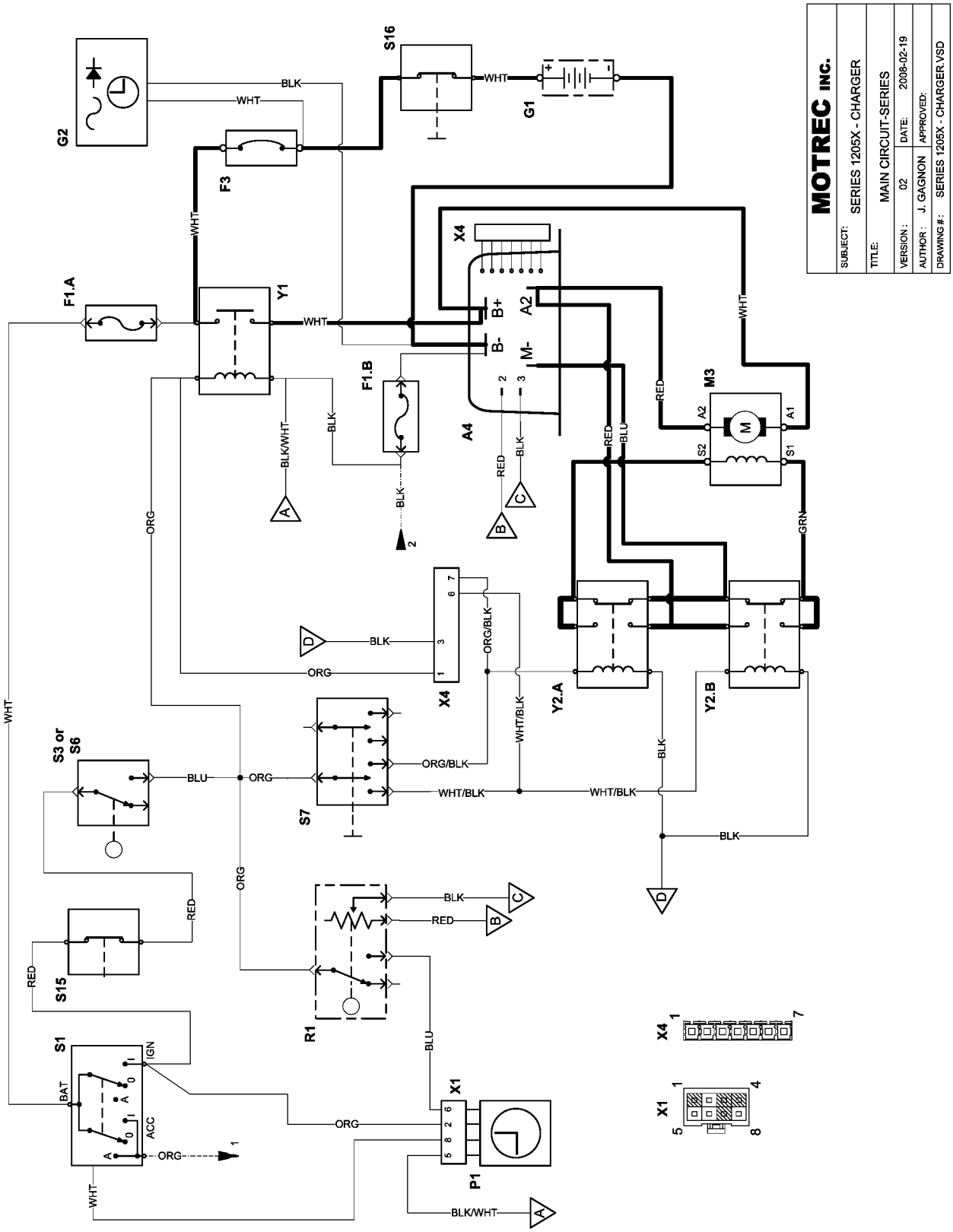
SPECIFIC

REF	*DESCRIPTION*	*A89*	*B98*	*A00*	*D00 SEPEX*	*DC3 SEPEX*	*DANA DRIVE*
	MOTOR ASS'Y	484000	204050	2450002	2450003	3112210001	3112230001
13	BRUSH SPRING	484010	484010	2450006	2450006	2450006	2450006
14	BRUSH PLATE	484011	484011	2450007	2450007	2450007	2450007
16	LEAD ASSY.	484017	484017	N/A	N/A	N/A	N/A
17	BRUSH	484009	484009	N/A	N/A	N/A	N/A
18	LEAD AND BRUSH ASSY.	N/A	N/A	2450008	2450008	3112210004	2450008

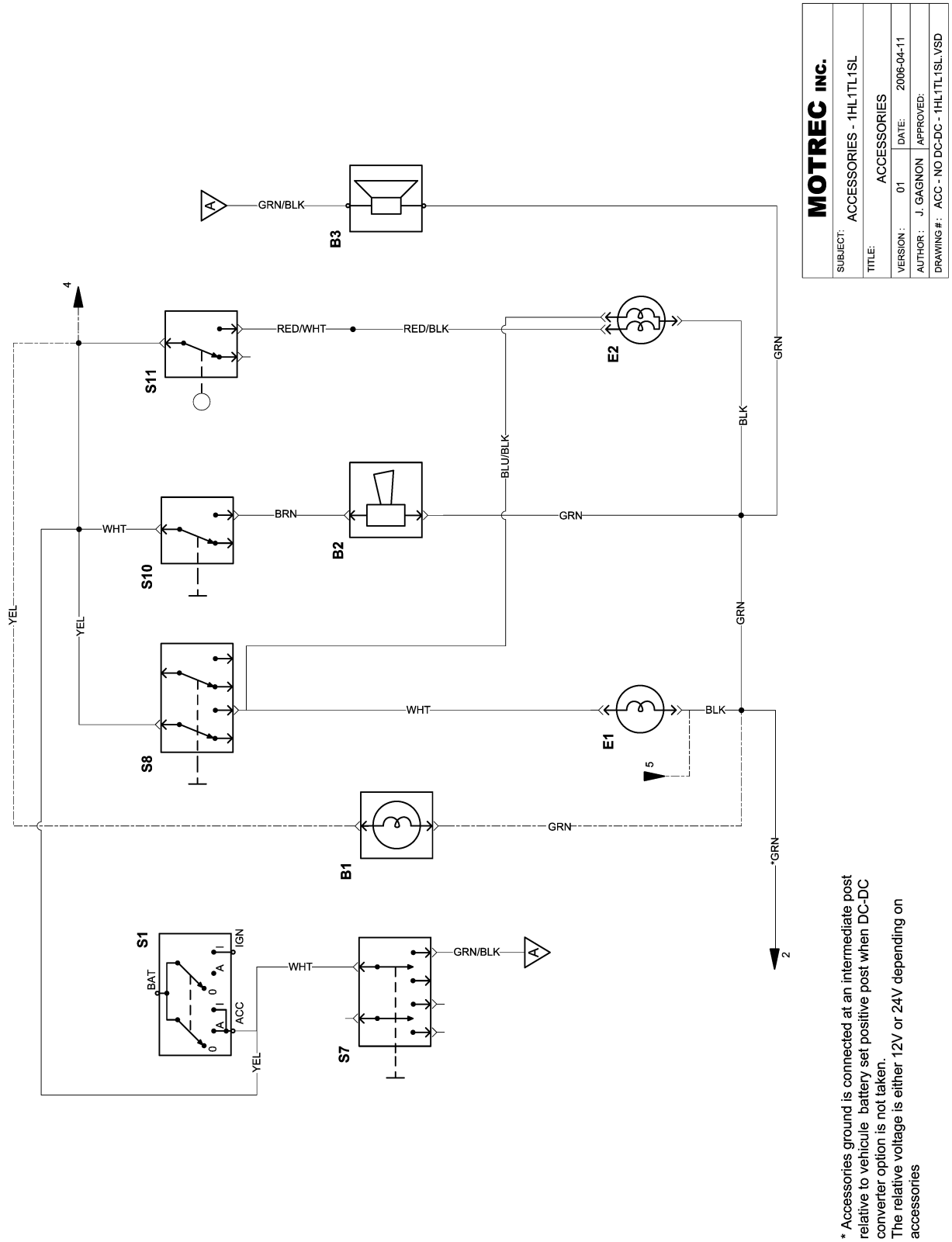
ELECTRICAL DIAGRAM – SEPEX MAIN CIRCUIT
DIAGRAMME ÉLECTRIQUE – CIRCUIT PRINCIPAL SEPEX



ELECTRICAL DIAGRAM – SERIES MAIN CIRCUIT
DIAGRAMME ÉLECTRIQUE – CIRCUIT PRINCIPAL SÉRIES

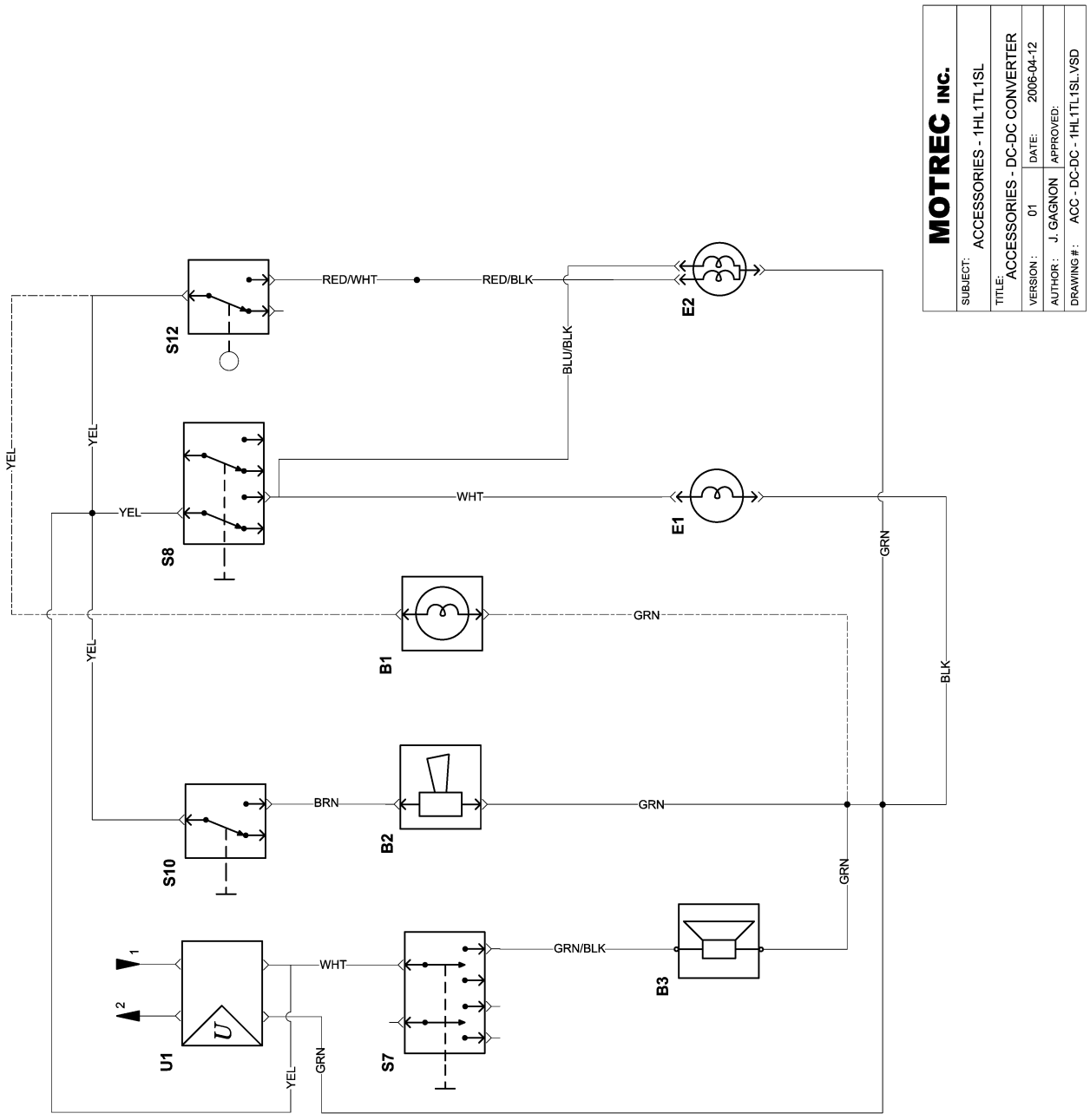


ACCESSORIES – NO DC/DC CONVERTER
ACCESSOIRES – SANS CONVERTISSEUR DC/DC



* Accessories ground is connected at an intermediate post relative to vehicule battery set positive post when DC-DC converter option is not taken.
The relative voltage is either 12V or 24V depending on accessories

ACCESSORIES – DC/DC CONVERTER
ACCESSOIRES – CONVERTISSEUR DC/DC



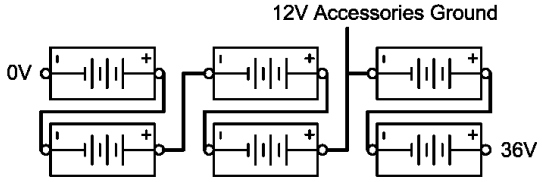
PARTS LIST

NO	DESIGNATION	REF	QTY
A2	SEPEX SPEED CONTROL	1244-5461	1
A3	SERIES SPEED CONTROL, 350A	1205X-5301	1
B1	STROBELIGHT	*	1
B2	HORN	*	1
B3	REVERSE ALARM	*	1
E1	HEADLIGHT	*	1
E2	TAIL/BRAKE LIGHT	*	1
F1.A,B	FUSE, 15A	246108K	2
F3	CIRCUIT BREAKER, 150A	3107000002	1
F4.A,B	DIODE	367012	3
F5	DIODE BRIDGE	3669027	1
G1	BATTERY		
G2	BATTERY CHARGER		1
M2	SEPEX MOTOR		1
M3	SERIES MOTOR		1
P1	INDICATOR (BDI), HOUR METER	*	1
R1	ACCELERATOR	2142100001	1
	MICROSWITCH	367002	1
	POTENTIOMETER	367003	1
	PLASTIC GEAR	367015	1
	SPRING	2462008	1
R4	RESISTANCE, 250 OHMS	367014	1
S1	KEY SWITCH	246205	1
S3	SEAT SWITCH, MICRO-SWITCH	3109100002	1
	SEAT SWITCH, SEAT MOUNTED	3109000003	1
	CONNECTOR	3109000004	1
S6	FOOT SWITCH	1269003	1
S7	FOWARD/REVERSE SELECTOR	266211	1
S8	LIGHT SWITCH, ROCKER TYPE	1269004	1
S10	HORN BUTTON	*	1
S12	BRAKE LIGHT SWITCH	246207	1
	HYDRAULIC BRAKE LIGHT SWITCH	3669004	1
S15	EMERGENCY PUSH BUTTON, CONTROL	3109800001	1
	EMERGENCY PUSH BUTTON LABEL	3109800006	1
S16	EMERGENCY PUSH BUTTON, BATTERY	3109000005	1
U1	DC-DC CONVERTER		1
X1	HOUR METER CONNECTOR		1
X2	SPEED CONTROL CONNECTOR		1
X5	BATTERY CHARGER CONNECTOR		1
Y1	MAIN CONTACTOR – 36V	3104236001	1
	MAIN CONTACTOR – 48V	486222	1
Y2.A,B	F/R CONTACTOR – 36V	366217	2
	F/R CONTACTOR – 48V	486217	2
	F/R BUSSBARS	2469003	1
	STATIC STRAP	2450001	1

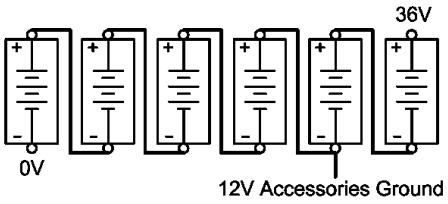
* Consult Motrec Illustrated parts

BATTERY CONFIGURATIONS - 36V
CONFIGURATIONS DES BATTERIES – 36V

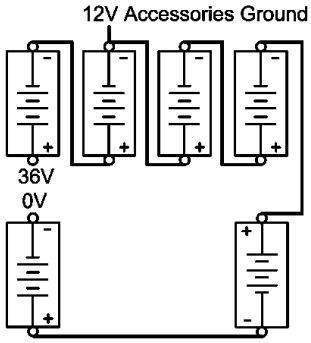
E-280B LIFT-OUT
E-320
E-330
E-360



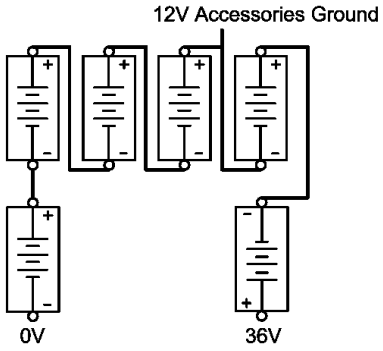
E-300
E-302
E-322



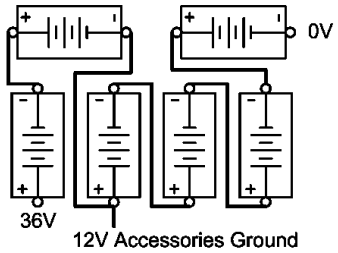
E-276



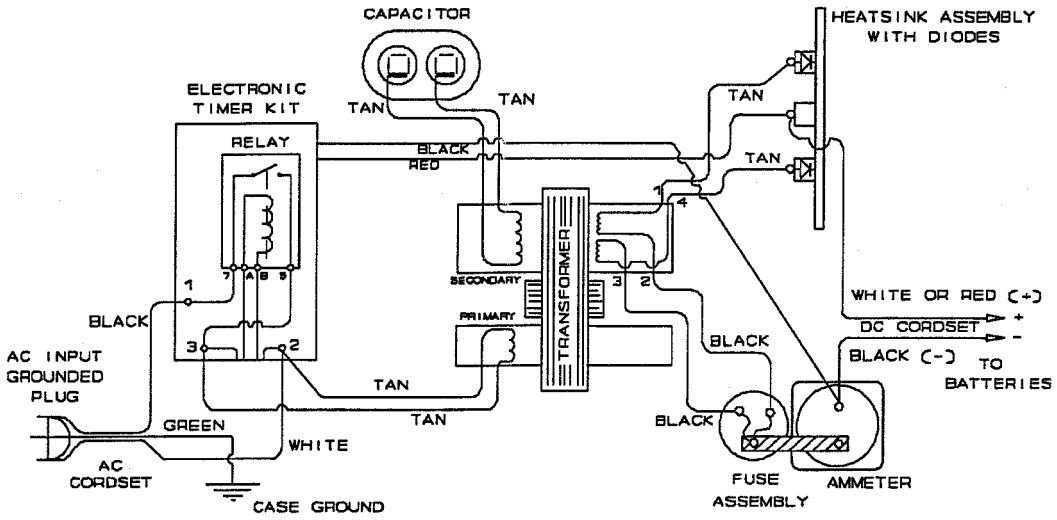
E-266



E-266 ROLL-OUT



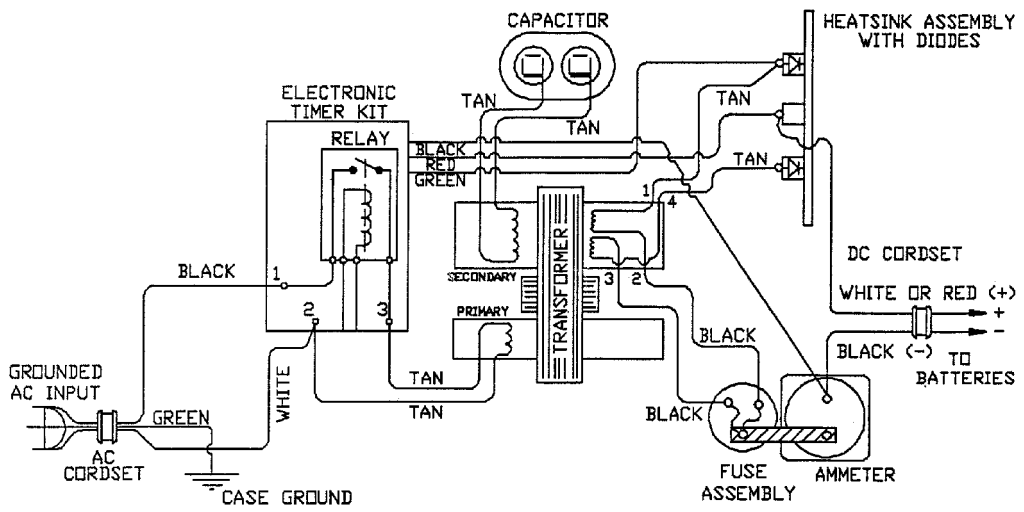
BUILT-IN CHARGER MODEL 6430-00



Parts list for LESTRONIC II charger MODEL 06430
TYPE 36LC25-8ET 115 VAC 60 Hz

PART NO	***DESCRIPTION***
07335S	CASE ASSEMBLY
18687S	CASE ASSEMBLY, WITH NO HANDLE
09691S	TRANSFORMER ASSEMBLY
02390S	CAPACITOR, 6.0 MFD, 660 VAC
16354S	HEATSINK ASSEMBLY, WITH DIODES
08776S	FUSE ASSEMBLY
04127S	AMMETER, 0-30 AMP
09685S	ELECTRONIC TIMER ASSEMBLY (RELAY – 04484S)
04484S	RELAY, TIMER KIT, 36 VDC
02028S	BUSHING, 7W-2, INSULATOR FOR DC CORD
02506S	CORDSET, AC, 14/3, 72”
11327S	CORDSET, AC, 14/3, 18”
13895S	CORDSET, AC, 14/3, 114”
08512S	CORDSET, DC, NO PLUG, 12/2, 108”
12781S	CORDSET, DC, GREY RUBBER PLUG, 12/2, 108”
09522S	CORDSET, DC, NO PLUG, 2 #10 AWG, 160”
08020S	CORDSET, DC, WITH LESTER PLUG
08607S	CORDSET, DC, WITH 50 AMP ANDERSON PLUG
08224S	CORDSET, DC, WITH 175 AMP ANDERSON PLUG
11328S	CORDSET, DC, WITH RING TERMINALS
08313S	PLUG ASSY, DC, 50 AMP ANDERSON PLUG
02957S	PLUG ASSY, DC, 175 AMP ANDERSON PLUG
04328S	RECEPTACLE, MOTOR BASE, 125/15

PORTABLE CHARGER MODEL 07710-02

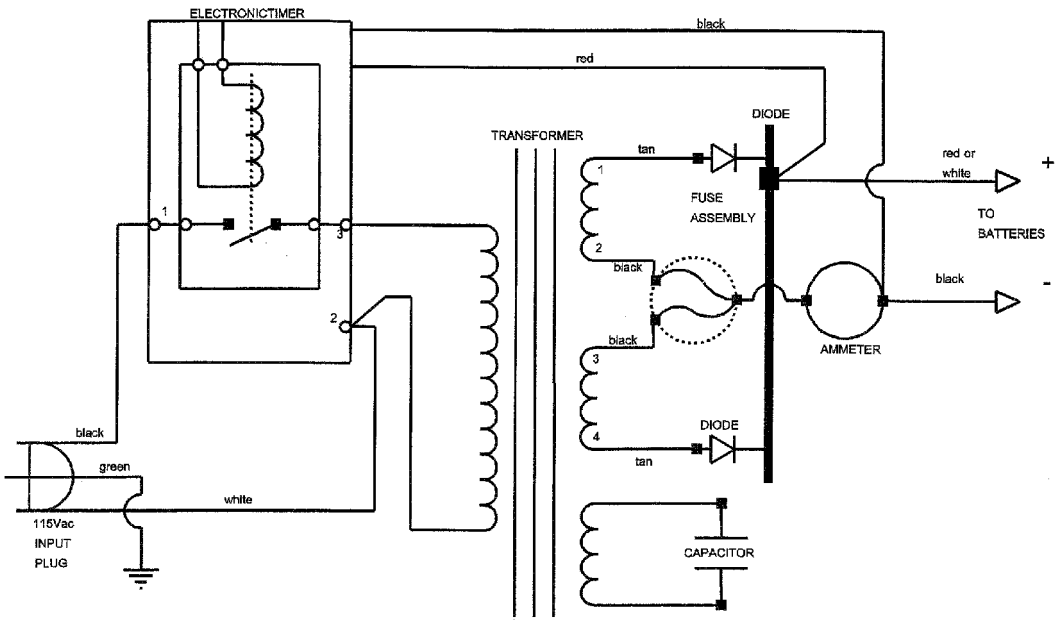


Parts list for LESTRONIC II charger MODEL 07710
TYPE 36LC25-8ET 115 VAC 60 Hz

PART NO	***DESCRIPTION***
07377S	CASE ASSEMBLY
07849S	TRANSFORMER ASSEMBLY
02390S	CAPACITOR, 6.0 MFD, 660 VAC
16354S	HEATSINK ASSEMBLY, WITH DIODES
08776S	FUSE ASSEMBLY
04127S *	AMMETER, 0-30 AMP
16369S **	AMMETER, 0-30 AMP
06357S	ELECTRONIC TIMER ASSEMBLY (RELAY – 04484S)
04484D	RELAY, TIMER KIT, 36 VDC
02028S	BUSHING, 7W-2, INSULATOR FOR DC CORD
11923S	CORDSET, AC
09522S	CORDSET, DC, 2-#10 AWG, 160”, NO PLUG
08512S	CORDSET, DC, NO PLUG
08020S	CORDSET, DC, WITH LESTER PLUG
12781S	CORDSET, DC, WITH GREY LESTER PLUG
08607S	CORDSET, DC, WITH 50 AMP ANDERSON PLUG
08224S	CORDSET, DC, WITH 175 AMP ANDERSON PLUG
10536S	CORDSET, DC, WITH 130” 50 AMP & EZ GO PLUG
08313S	PLUG ASSY, DC, 50 AMP ANDERSON PLUG
02957S	PLUG ASSY, DC, 175 AMP ANDERSON PLUG

* For use with chargers built before Dec. ‘90
** For use with chargers built after Dec. ‘90

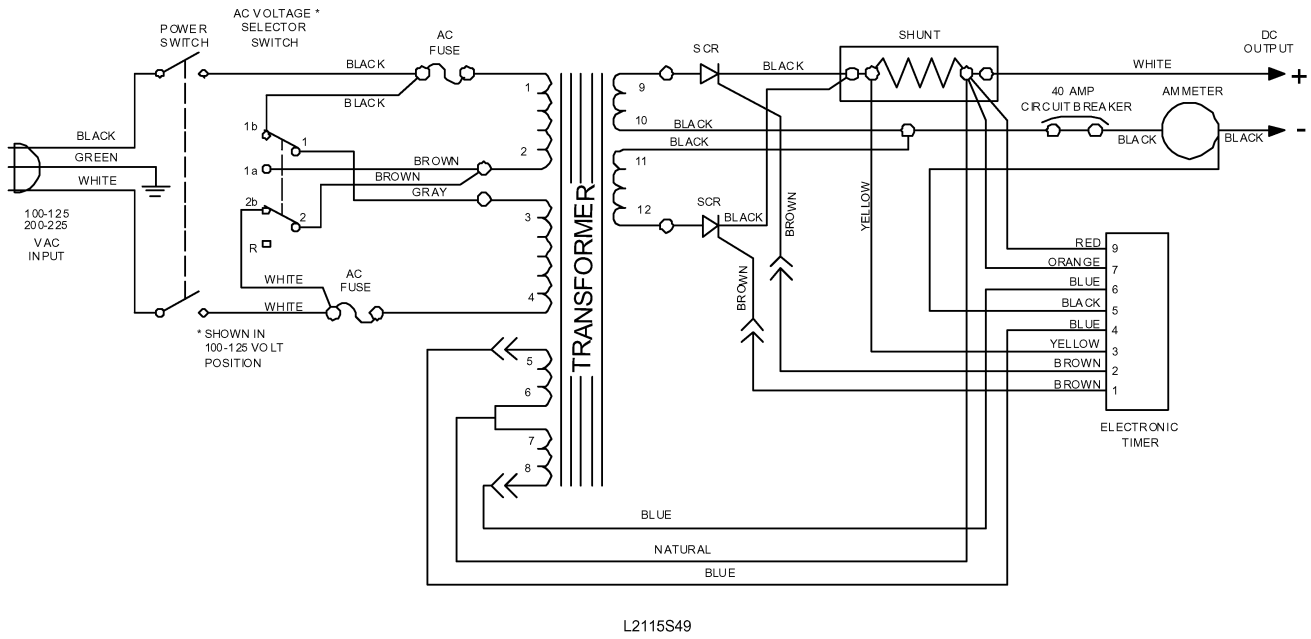
BUILT-IN/PORTABLE 40A CHARGER



Parts list for LESTRONIC II charger MODEL 09475
TYPE 36LC40-8ET 115 VAC 60 Hz

PART NO	***DESCRIPTION***
09477S	CASE ASSEMBLY
09476S	TRANSFORMER ASSEMBLY
09041S	HEATSINK ASSEMBLY, WITH DIODES
08849S	DIODE ASSEMBLY
16823S	AMMETER
09685S	ELECTRONIC TIMER ASSEMBLY
02390S	CAPACITOR, 6.0 MFD, 660 VAC
02008S	BUSHING, 8P-2, INSULATOR FOR DC CORD
02028S	BUSHING, 7W-2, INSULATOR FOR AC CORD
02506S	CORDSET, AC
08511S	CORDSET, DC, NO PLUG
18771S	CORDSET, DC, WITH MOLDED PLUG, GREY
08067S	CORDSET, DC, WITH LESTER PLUG
08069S	CORDSET, DC, WITH 50 AMP GREY PLUG
08329S	CORDSET, DC, WITH 175 AMP GREY PLUG
20331S	CORDSET, DC, WITH 175 AMP YELLOW PLUG
09434S	CORDSET, DC, WITH 350 AMP GREY PLUG
08313S	PLUG ASSY, DC, 50 AMP ANDERSON PLUG
02957S	PLUG ASSY, DC, 175 AMP ANDERSON PLUG
08774S	FUSE ASSEMBLY

BUILT-IN/PORTABLE CHARGER MODEL 16360-40

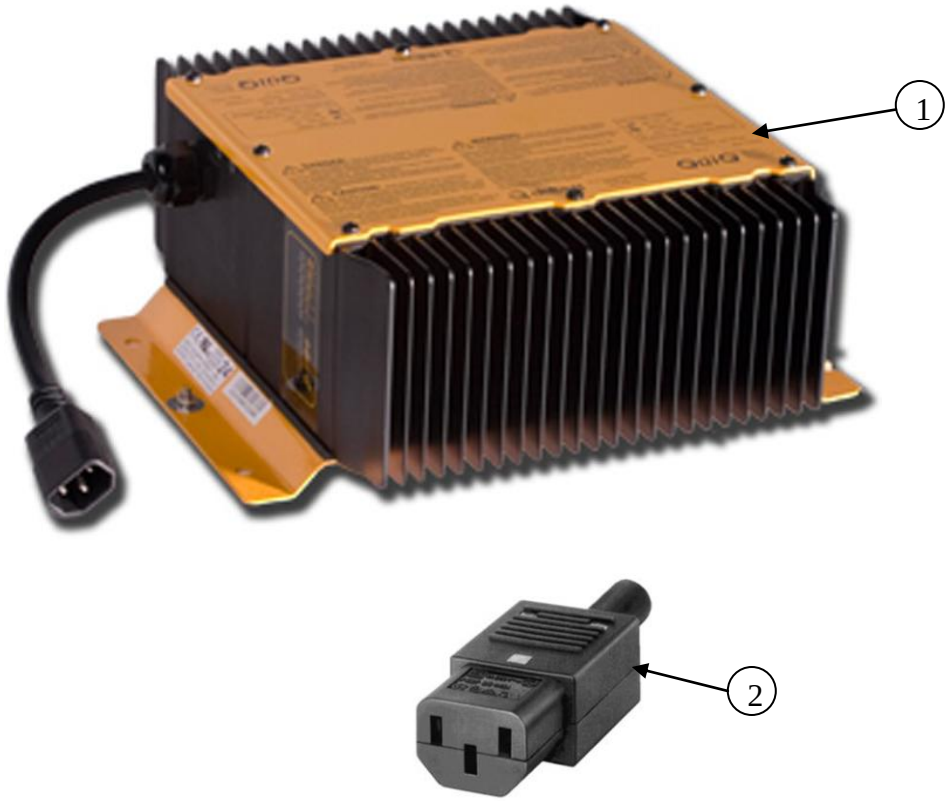


L2115S49

Parts list for MODEL 16360-40
TYPE 36EL20-8ET
100-125 or 200-250 VAC / 50-60 Hz

PART NO	*QTY.*	*DESCRIPTION*
20952S	1	CASE ASSEMBLY
16365S	1	TRANSFORMER ASSEMBLY
16369S	1	AMMETER
20919S	2	HEATSINK ASSEMBLY, W/ SCR
20948S	2	SCR ASSEMBLY
21475S	1	ELECTRONIC TIMER ASSEMBLY
19233S	1	CONTROL CABLE ASSEMBLY
02028S	1	BUSHING, INSULATOR, 7W-2, FOR DC CORDSET
03894S	1	BUSHING, INSULATOR, 7K-2, FOR AC CORDSET
20916S	1	CORDSET, AC, 16/3, 80”, MOLDED PLUG
20924S	1	CORDSET, DC, 12/2, 108”, SB-50 PLUG, GRAY
20914S	1	CORDSET, DC, 12/2, 108”, SB-50 PLUG, RED
20926S	1	CORDSET, DC, 12/2, 108”, SB-175 PLUG, RED
21912S	1	CORDSET, DC, 12/2, 108”, SB-175 PLUG, GRAY
21408S	1	CORDSET, DC, 12/2, 108”, NO PLUG
05322S	2	FUSEHOLDER
15029S	2	FUSE, 12 AMP, MDA-12
20917S	1	SWITCH ASSEMBLY
18696S	1	SHUNT, ELECTRONIC
14092S	1	CIRCUIT BREAKER, 40 AMP

DELTA-Q HF CHARGER



NO	*PART NO*	*DESCRIPTION*
1	3102240002	24V CHARGER (U.S. BATTERY)
	3102240003	24V CHARGER (LIFELINE BATTERY)
	3102240004	24V CHARGER (GEL 180AH BATTERY)
	3102240005	24V CHARGER (27TM BATTERY)
	3102302001	36V CHARGER (U.S. BATTERY)
	3102302002	36V CHARGER (LIFELINE BATTERY)
	3102302003	36V CHARGER (GEL 180AH BATTRY)
	3102480002	48V CHARGER (U.S. BATTERY)
	3102480003	48V CHARGER (LIFELINE BATTERY)
	3102480004	48V CHARGER (GEL 180AH BATTERY)
2	3119000011	CONNECTOR C13

QuiQ™ HF/PFC Battery Charger

Product Manual for:
QuiQ 912-24xx / 36xx / 48xx / 72xx

delta-q TECHNOLOGIES
Unit 3 – 5250 Grimmer St.
Burnaby, BC, Canada V5H 2H2
Tel: 604.327.8244 Fax: 604.327.8246
www.delta-q.com

SAVE THESE IMPORTANT SAFETY INSTRUCTIONS

This manual contains important safety, operating, and installation instructions – read before using charger.

Battery Safety Information

Warning: Use charger only on battery systems with an algorithm selected that is appropriate to the specific battery type. Other usage may cause personal injury and damage. Lead acid batteries may generate explosive hydrogen gas during normal operation. Keep sparks, flames, and smoking materials away from batteries. Provide adequate ventilation during charging. Never charge a frozen battery. Study all battery manufacturers' specific precautions such as recommended rates of charge and removing or not removing cell caps while charging.

Electrical Safety Information

Danger: Risk of electric shock. Connect charger power cord to an outlet that has been properly installed and grounded in accordance with all local codes and ordinances. A grounded outlet is required to reduce risk of electric shock – do not use ground adapters or modify plug. Do not touch uninsulated portion of output connector or uninsulated battery terminal. Disconnect the AC supply before making or breaking the connections to the battery while charging. Do not open or disassemble charger. Do not operate charger if the AC supply cord is damaged or if the charger has received a sharp blow, been dropped, or otherwise damaged in any way – refer all repair work to qualified personnel. Not for use by children.

INFORMATIONS IMPORTANTES DE SÉCURITÉ

Conserver ces instructions. Ce manuel contient des instructions importantes concernant la sécurité et le fonctionnement.

Information de Sécurité de la Batterie

Attention: Utiliser seulement sur les batteries 72V avec un algorithme approprié au type spécifique de batterie – voire le manuel. D´autres types de batteries pourraient éclater et causer des blessures ou dommages. Les batteries peuvent produire des gaz explosives en service normal. Ne jamais fumer près de la batterie et éviter toute étincelle ou flame nue à proximité de ces derniers. Fournisser la bonne ventilation lors du chargement. Ne jamais charger une batterie gelée. Prendre connaissance des mesures de précaution spécifiées par le fabricant de la batterie, p. ex., vérifier s´il faut enlever les bouchons des cellules lors du chargement de la batterie, et les taux de chargement recommandés.

Information de Sécurité Électrique

Danger: Risque de chocs électriques. Ne pas toucher les parties non isolées du connecteur de sortie ou les bornes non isolées de la batterie. Toujours connecter le chargeur à une prise de courant mise à la terre. Ne pas ouvrir ni desassembler le chargeur – referer toute reparations aux personnes qualifiés. Pas à l´usage des enfants.

Operating Instructions

1. Always use a grounded outlet. When using an extension cord, avoid excessive voltage drops by using a grounded 3-wire 12 AWG cord.
2. The charger will automatically turn on and go through a short LED indicator self-test (Models 912-xx0x will flash all LED's in an up-down sequence and Models 912-xx1x will alternatively flash its LED RED-GREEN) for two seconds. If the charger is connected to battery pack, a trickle current will be applied until a minimum voltage is reached. If the charger is used in an off-board application and the charger is waiting to be plugged into a battery pack, the charging algorithm number will be displayed for 11 seconds (see "Check / Change Charging Algorithm") before ultimately displaying an under-voltage fault (fault disappears when plugged into battery pack).
3. Once a minimum battery voltage is detected, the charger will enter the bulk charging constant-current stage. Models 912-xx0x will display the current to the battery on the bargraph and Model 912-xx1x will flash its LED GREEN off more than on to indicate <80% charge status. The length of charge time will vary by how large and how depleted the battery pack is, the input voltage (the higher, the better), and ambient temperatures (the lower, the better). If the input AC voltage is low (below 104VAC), then the charging power will be reduced to avoid high input currents (Models 912-xx0x 'AC' LED and Models 912-xx1x single LED both flash YELLOW). If the ambient temperature is too high, then the charging power will also be reduced to maintain a maximum internal temperature (Models 912-xx0x bargraph flashes and Models 912-xx1x single LED flashes YELLOW).
4. When the battery is at approximately 80% state of charge, the bulk stage has completed and an >80% charge indication is given (Models 912-xx0x turn on the '80%' LED and Models 912-xx1x will flash its LED GREEN on more than off). In the next phase known as the absorption or constant-voltage phase, the last 20% of charge is then returned to the battery. The charging could be terminated at this point if the vehicle requires immediate usage, however, it is highly recommended to wait until 100% charge indication is given to ensure maximum battery capacity and life.
5. A low current "finish-charge" phase is next applied to return and maintain maximum battery capacity (Models 912-xx0x will flash the '100%' LED).
6. When Models 912-xx0x '100%' LED or Models 912-xx1x single LED is continuously GREEN, the batteries are completely charged. The charger may now be unplugged from AC power (always pull on plug and not cord to reduce risk of damage to the cord). If left plugged in, the charger will automatically restart a complete charge cycle if the battery pack voltage drops below a minimum voltage or 30 days has elapsed.
7. If a fault occurred anytime during charging, a fault indication is given by flashing RED with a code corresponding to the error. There are several possible conditions that generate errors. Some errors are serious and require human intervention to first resolve the problem and then to reset the charger by interrupting AC power for at least 15 seconds. Others may be simply transient and will automatically recover when the fault condition is eliminated. To indicate which error occurred, a fault indication will flash RED a number of times, pause, and then repeat.
   [1 FLASH] Battery Voltage High: auto-recover
   [2 FLASH] Battery Voltage Low: auto-recover
   [3 FLASH] Charge Timeout: the charge did not complete in the allowed time. This may indicate a problem with the battery pack (voltage not attaining the required level), or that the charger output was reduced due to high ambient temperatures.
   [4 FLASH] Check Battery: the battery pack could not be trickle charged up to the minimum level required for the charge to be started. This may indicate that one or more cells in the battery pack are shorted or damaged.
   [5 FLASH] Over-Temperature: auto-recover. Charger has shutdown due to high internal temperature which typically indicates there is not sufficient airflow for cooling – see Installation Instructions 1). Charger will restart and charge to completion if temperature comes within accepted limits.
   [6 FLASH] QuiQ Fault: an internal fault has been detected. If Fault 6 is again displayed after interrupting AC power for at least 15 seconds, the charger must be brought to a qualified service depot.

Maintenance Instructions

1. For flooded lead-acid batteries, regularly check water levels of each battery cell after charging and add distilled water as required to level specified by battery manufacturer. Follow the maintenance and safety instructions recommended by the battery manufacturer.
2. Make sure charger connections to battery terminals are tight and clean.
3. Do not expose charger to oil, dirt, mud or to direct heavy water spraying when cleaning vehicle.

See flip side for **Product Specifications** and **Installation Instructions** for qualified personnel.

Specifications

DC Output – see Operating Instructions

QuiQ Model: 912-	24xx	36xx	48xx	72xx
Voltage-nom (V)	24	36	48	72
Voltage-max (V)	33.6	50.4	67.2	100
Current-max (A)	25	21	18	12
Battery Type	Specific to selected algorithm			
Reverse Polarity	Electronic protection – auto-reset			
Short Circuit	Electronic current limit			

AC Input

All models	
Voltage-max (Vrms)	85 – 265
Frequency (Hz)	45 - 65
Current-max (Arms)	12A @ 104VAC (reduced 20%<104V)
Current – nominal (Arms)	10A @ 120VAC / 5A @ 230VAC
AC Power Factor	>0.98 at nominal input current

Operation

Charger Model: 912-	xx0x (10 LED)	xx1x (1 LED)
AC ON	Solid YELLOW	LED Active
AC LOW	Flash YELLOW	Flash YELLOW
Thermal Cutback	Flash Bargraph	Flash YELLOW
<80% Charge Indicator	-	Short Flash GREEN
>80% Charge Indicator	Solid YELLOW	Long Flash GREEN
100% Charge Indicator	Solid GREEN	Solid GREEN
Fault Indicator	Flash RED	Flash RED
DC Ammeter	LED Bargraph	-
Bat Temp Compensation	Automatic	Optional
Maintenance Mode	Auto-restart if V<2.1Vpc or 30 days elapse	

Mechanical

All models	
Dimensions	28.0 x 24.5 x 11.0 cm (11 x 9.7 x 4.3")
Weight	<5 kg (<11 lbs) w/ standard output cord
Environmental	Enclosure: IP46
Operating Temperature	-30°C to +50°C (-22°F to 122°F), derated above 30°C, below 0°C
Storage Temperature	-40°C to +70°C (-40°F to 158°F)
AC input connector	IEC320/C14 (require ≥1.8m localized cord)
DC output connector	OEM specific w/ 12AWG wire

Regulatory

Safety	
EN 60335-1/2-29	Safety of Appliances/ Battery Chargers
UL2202	EV Charging System Equipment
UL1564 2nd Edition	Industrial Battery Charger
CSA-C22.2 No. 107.2	Battery Chargers- Industrial
Emissions	
FCC Part 15/ICES 003	Unintentional Radiators Class A
EN 55011	Radio disturbance characteristics (Class A)
EN 61000-3-2	Limits for harmonic current emissions
EN 61000-3-3	Limits of voltage fluctuations and flicker
Immunity	
EN 61000-4-2	Electrostatic discharge immunity
EN 61000-4-3	Radiated, radio-frequency, EMF immunity
EN 61000-4-4	Electrical fast transient/burst immunity
EN 61000-4-5	Surge immunity
EN 61000-4-6	Conducted Immunity
EN 61000-4-11	Voltage variations immunity

Installation Instructions

WARNING: The output of chargers with greater than 48V may pose an energy and/or shock hazard under normal use. These units must be installed in the host equipment in such a manner that the output cable and battery connections are only accessible with the use of a tool by qualified personnel.

1) Determine Mounting Location:
While its sealed nature allows the charger to be mounted virtually anywhere, the choice of mounting location and orientation is extremely important. For optimum performance and shortest charge times, mount the charger in an area with adequate ventilation. The charger should also be mounted in an area that will be relatively free of oil, dirt, mud, or dust since accumulations within the fins of the charger will reduce their heat-dissipating qualities. Optimal cooling also occurs when the charger is mounted on a horizontal surface with the fins vertical. More airflow from below the charger will help cool the fins, so mounting above open areas or areas with cut-outs for airflow is desirable. Contact Delta-Q for information on other mounting orientations. As the charger may get hot in operation, the charger must be installed such that risk of contact by people is reduced. The charger's AC plug must be located at least 18" above the floor/ ground surface and the status display must be visible to the user.

2) Mounting Procedure:
Mount the charger by the mounting plate using appropriate fasteners (i.e. 1/4" or M6 with locking hardware). For UL2202 compliance, a 12AWG green bonding wire with ring terminals must be attached from the bonding stud located on the front of the charger (identified by ⏚) to the vehicle frame. The vehicle connection must be made using corrosion resistant hardware (e.g., a #10 stainless steel machine screw with at least two threads of engagement and, if required, a paint piercing washer).

3) DC Battery Connection Procedure:
a) The green wire outputs battery voltage when the charger is not plugged into AC to provide an interlock function – see Fig. 1. **If used, a user-supplied 1A fast-blow external fuse must be installed inline to prevent damage. Shorting or drawing more than 1A may damage charger and void the warranty.**
b) Securely fasten the black ring terminal from the charger to the negative terminal ("-", "NEG", NEGATIVE") of the battery pack.
c) Check that the correct charge algorithm is being used – refer to section 4). Securely fasten the red ring terminal to the positive terminal ("+", "POS", "POSITIVE") of the battery pack.

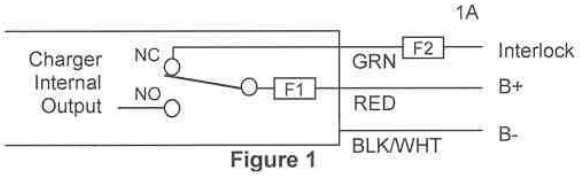


Figure 1

4) Check / Change Charging Algorithm:
The charger comes pre-loaded with algorithms for batteries as detailed in Table 1. If your specific battery model is not listed, please contact Delta-Q.
Each time AC power is applied with the battery pack NOT connected, the charger enters an algorithm select/display mode for approximately 11 seconds. During this time, the current Algorithm # is indicated on the '80%' LED (Models 912-xx0x) or on the single LED (Models 912-xx1x). A single digit Algorithm # is indicated by the number of blinks separated by a pause. A two digit Algorithm # is indicated by the number of blinks for the first digit followed by a short pause, then the number of blinks for the second digit followed by a longer pause.
To check / change the charging algorithm:
a) Disconnect the charger positive connector from battery pack. Apply AC power and after the LED test, the Algorithm # will display for 11 seconds.
b) To change algorithm, touch positive connector during the 11 second display period to the battery pack's positive terminal for 3 seconds and then remove – the Algorithm # will advance after 3 seconds. Repeat until desired Algorithm # is displayed. A 30 second timeout is extended for every increment. Incrementing beyond the last Algorithm moves back to the first Algorithm. After desired Algorithm # is displayed, touch the charger connector to the battery positive until the output relay is heard to click (~10 seconds) – algorithm is now in permanent memory.
c) Remove AC power from the charger and reconnect the charger positive connector to the battery pack. It is highly recommended to check a newly changed algorithm by repeating step 4) above.

Alg #	Battery Type
35	Concorde 2xxAh AGM
27	Crown CR325 dv/dt
26	Deka 8GGC2 Gel
11	generic flooded CP dv/dt
8	Concorde 1xxAh AGM
7	Trojan J305 dV/dt
6	DEKA 8G31 Gel
5	Trojan 30XHS
4	US Battery US2200
1	Trojan T-105

Table 1.

Product warranty is two years - please contact dealer of original equipment for warranty service.

Note: This is a Class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

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MOTREC ILLUSTRATED ACCESSORIES

Strobelight, polemount
Amber 12-80V: 3116000001
Red 12-80V: 2469001
Blue 12-80V: 3690008

Strobelight, cab mount
Amber 12-48V: 3116250001
Red 12-48V: 3069026
Blue 12-48V: 3069014
Amber 72-80V:3116720001
Red 72-80V: 3116720002
Blue 72-80V: 3116720003

Amber turn lamp
12V: 3069020
Bulb 12V: 3069021
Multi-LED amber turn lamp
Round Light: 3111000010
Grommet: 3111000008
Plug: 3111000009

Red Tail/Brake light
Grommet: 3269001
Plug: 246012A
12V : 2469021
24V : 2469022

Red Tail/Brake light
Housing: 3069012R
Bulb 12V: 3117240001

Back-up lamp
Grommet: 3269001
12V: 3669012
24V: 3669012A

Clear lamp
12V: 3069012
Bulb 12V: 1269008

Pedestral head lamp
12V: 2569001
Bulb 12V: 2569001B
Bulb 24V: 4469001

Headlight
Left: 3111480003
Right: 3111480004
Bulb H/L: 3111480006
Bulb Turn: 3111480008
Bulb Mark: 3111480007

Headlight
Left: 3111480003
Right: 3111480004
Bulb H/L: 3117480001
Bulb Turn: 3117480003
Bulb Mark: 3117480002

Turn signal switch
246050

Multi-LED Red Tail/Brake
Light: 3111000006
Grommet: 3111000008
Plug: 3119000009

Multi-LED Back-up
Light: 3111000007
Strobe light: 3111000013
Grommet: 3111000008
Plug: 3119000009

Red Tail/Brake light
12V: 386002

Horn button VIP
2330014

Horn button, column mount
246210

Horn button, dash mount
266210

Horn button 3109250001

Limit switch
3030015

Horn
12V: 246003
24V: 246013

Analog Voltmeter

12V :	3069007
24V :	2469002
36-48V :	3669002

HOBBS Gauge

24V:	2469026
36V:	3069038
48V:	4869037

DC-DC converter, 10A

12-48V:	3069019

DC-DC Converter, 25A

12-48V:	3124000002
72-80V:	3124880001

Wiper motor

12V:	3113000001
24V:	486211

Wiper arm 2800000001

Wiper blade

14” Blade:	2800000002
18” Blade:	2800000003

Pantograph wiper arm 246233A

Pantograph wiper blade 246233

Cab heater

12V:	3103300001
36V:	3669008
48V:	4869020

12V Dome light 3669006

12V Fan 3669013

Headlamp 12V:3111250002

Headlamp

12V:	3111300001
Bulb 12V:	3111300002

Red Pilot light

12V:	246212
Bulb 12V:	246212B

Back-up alarm or Motion beeper

12-48V :	3100000001
72-80V :	3105720001
12-24V Adjustable:	3100000002

CONVERTER INSTALLATION

Installation and Trouble Shooting Guide
SY1200-25

The SY1200-25 is a state of the art DC-DC converter. There are many new features, and special care is required to install this unit properly. If you have problems with the operation of this unit please check the installation procedures for help.

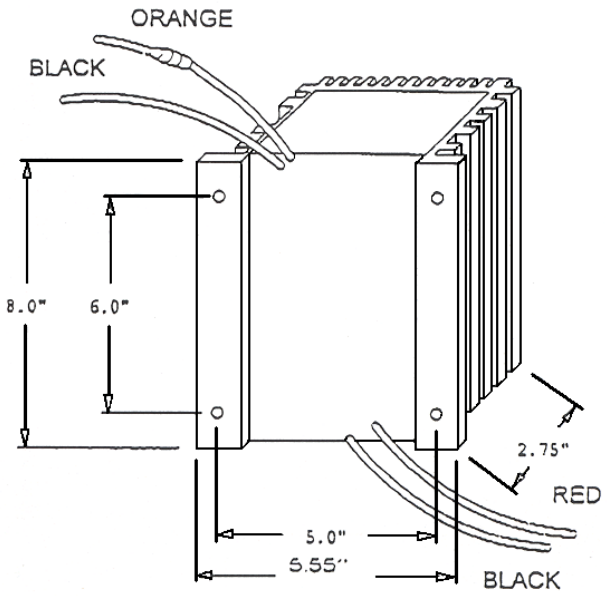
The **ORANGE** wire is the **INPUT POSITIVE>**

The **BLACK** wire near the orange wire is the **INPUT NEGATIVE>**

The RED wire is the **OUTPUT POSITIVE.**

The **BLACK** wire near the red wire is the **OUTPUT NEGATIVE.**

NOTE: Use the correct black wire for input and output. Do not connect the black wires together. (The black wires are common however, due to the high currents developed in this unit it is necessary to maintain proper electron flow to reduce noise.)



The converter must be mounted on a metal surface for proper heat dissipation. A vertical mounting position is best to maximize the convection process. The unit will shut down thermally under high currents if not properly mounted.

This unit is equipped with digital logic capabilities. The input voltage is monitored to determine acceptability. If the input voltage is below the MIN or above the MAX limits the SY1200-25 will NOT turn on.

The fuse in this unit has no determining factors as to the current carrying capabilities of the converter. The fuse serves only one purpose, and that is to remove the unit from your power source in the event of a failure. The SY1200-25 has a very advanced control section, and will determine when to open the fuse. An open fuse will mean, that a problem had occurred, that does not mean that the problem still exists, or that the problem has gone away.

<<DO NOT increase or by'pass the fuse. USE ONLY A FUSE RATED AT 250V 20A>>

Potential reasons for an open fuse are as follows: (1) The output voltage rises above 18 VDC. This problem can occur when an inductive load is removed or applied at high currents. This is a noise spike and the converter will shut down if it can not suppress the spike. (2) Reverse polarity on the input or output. (3) A chaos condition where the output becomes unstable. (4) Excessive noise or spikes on the input.

Mount this unit as close to the highest current load as possible. (This unit uses true switching techniques to step down the input voltages. The higher the input voltage the lower the input current for a 25 AMP load. The high currents are on the output of the converter.) Use 14 gauge wire for the input up to 5 feet. Use 12 gauge wire for up to 10 feet. Increase the wire gauge for each additional 5 feet of wire. NEVER use less than a 10 gauge wire on the output. If the wire length exceeds 5 feet use 8 gauge wire. IMPORTANT: Use a crimp type of connector to attach the wire to the converter. DO NOT twist the wires together. A poor connection will not only allow the converter to operate poorly, but at 25 amps the connection WILL GET HOT AND BURN IN TWO.

WARNING: THE CHASSIS IS ISOLATED FOR HIGH VOLTAGE APPLICATIONS. DO NOT USE THE CHASSIS FOR GROUND.

BATTERY DISCHARGE INDICATOR (HOBBS)

This indicator monitors :
- the residual capacity of batteries;
- operating hours;
- status of service down counter.

The residual capacity of the battery is monitored via an 8-LED bar display. When the left red LED lights, the batteries must be charged to avoid damage. The LED display starts flashing as a pre-warning signal. The lower voltage limit is adjustable via potentiometer "M" on the rear.

A	B	C	D	E	F	G	H	I	J	K
1,57	1,63	1,68	1,73	1,78	1,82	1,84	1,86	1,89	1,91	1,93

In order to activate a new adjustment, the unit has to be reset :
- 2.35V/cell reset voltage with battery remaining in vehicle;
- 2,09V/cell reset voltage after battery has been disconnected.

To maintain a good battery performance, it is recommended to limit the discharging to 80% of the battery capacity. The recommended setting for 6V batteries is F and the recommended setting for an industrial battery is K.

An internal relay can prevent overdischarging and damaging the batteries. The relay can be wired to cut off the reverse direction, or energize an N.C. relay and alarm.
Turning off and on the vehicle will override the protection for 30 sec.

The current status (remaining operating hours before maintenance) of the service down counter is indicated for a period of 5 seconds after the key switch is turned on. When it is down to 0, the display flashes. After the maintenance, reset the counter: depress the button "R" on the rear. The service counter is factory programmable only.

24V UNIT #: 2469026
36V UNIT #: 3069038
48V UNIT #: 4869037

2- Orange, key switch
3- Relay +
4- Relay -
5- Black, battery –
6- Blue, hour counter
8- White, battery +